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PRECONCENTRATION OF A LOW GRADE URANIUM ORE IN CPDU AND LABORATORY INVESTIGATION TO OPTIMIZE THE DEWATERING CONDITIONS OF THE PRECONCENTRATION PRODUCTS

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by

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ABSTRACT

A technological concept consisting of pyrite flotation and magnetic concentration of radionuclides was developed by CANMET over several years, to preconcentrate low grade uranium ores prior to leaching. When the economics of the Preconcentration-leaching technology was compared with the leaching of the entire ore after pyrite flotation (Base Case variant), the Preconcentration method appeared to be economically less advantageous than expected, due to the high cost of dewatering the preconcentration products.

The investigations were continued to examine in-depth the metallurgy and dewatering conditions of the two variants: Preconcentration and Base Case.

A typical low grade uranium ore from Elliot Lake area was used for the testwork.

The metallurgy of the two variants was compared based on data from continuous operation (CPDU). In the Preconcentration variant the amount of ore directed to leaching was reduced to more than one third of that processed in the Base Case, while the radionuclides concentration became more than three times higher. However, by preconcentration 7% of the uranium was lost before leaching.

Systematic settling and filter tests conducted on laboratory scale managed to optimize the less favourable dewatering conditions of the Preconcentration technology to the extent that rates similar to those of the Base Case was obtained.

Using the data of this testwork the economics of the two variants can be evaluated and compared on a more realistic basis.

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PRÉCONCENTRATION D'UN MINERAI D'URANIUM À FAIBLE TENEUR DANS UNE UNITÉ DE TRAITEMENT EN CONTINU ET ESSAIS DE LABORATOIRE POUR OPTIMISER LES CONDITIONS D'ÉPAISSISSAGE ET DE FILTRATION DES PRODUITS DE PRÉCONCENTRATION

par

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RÉSUMÉ

Un nouveau procédé incorporant la flottation de la pyrite et la concentration magnétique de radionucléides a été développé par CANMET au cours des dernières années dans le but de préconcentrer les minerais d'uranium à faible teneur avant leur lixiviation.

Une comparaison économique préliminaire entre le procédé de préconcentration suivi d'une lixiviation et le procédé de lixiviation du tout-venant après flottation de la pyrite semblait démontrer que les coûts plus élevés d'épaississage et de filtration désavantageaient le procédé de préconcentration. Des études furent donc poursuivient pour examiner en détail les conditions de traitement et d'égouttage de ces deux procédés; le minerai choisi était en provenance d'Elliot Lake et était constitué de matériel typique à basse teneur d'uranium.

Les résultats métallurgiques qui ont servi à établir la comparaison furent obtenus par une unité de traitement en continu (UTC/CPDU). Le procédé préconcentration put réduire de presque deux tiers l'alimentation à l'étape de lixiviation tout en concentrant les radionucléides par trois fois en comparaison avec l'autre méthode. La méthode de préconcentration doit tout de même souffrir une perte de 7% d'uranium avant l'étape de lixiviation.

Une série d'essais en laboratoire de sédimentation et de filtration ont pu optimiser les conditions nécessaires pour permettre au procédé de préconcentration de se comparer très favorablement à l'autre méthode.

En se basant sur ces nouveaux résultats, il sera maintenant possible d'évaluer les aspects économiques de ces deux procédés et de les comparer d'une manière plus réalistique.

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INTRODUCTION

In previous years intensive testwork was performed in CANMET laboratories to deal with low grade uranium ores (1). The aim of the investigations was to solve two major objectives: a) preconcentrate the ore prior to leaching to make the entire process economically more attractive and b) produce environmentally acceptable tailings.

Both objectives were met. A process was developed to preconcentrate the ore prior to leaching and to produce environmentally virtual clean tailings as a result of the preconcentration process.

The preconcentration method consisted in pyrite flotation followed by the magnetic concentration of the flotation tailing. By applying this technology the amount of ore directed to leaching would be reduced to approximately one third of the original ore.

Cost estimate studies were then initiated to evaluate the economics of the new technological concept. At that time the conventional method for treating the uranium ore was the direct leaching process. The cost estimate studies tried however to evaluate and compare the economics of the preconcentration method with a variant of the conventional process, that was identified as Base Case and consisted in pyrite flotation followed by the hydrochloric leaching of the flotation tailing.

The cost estimate studies indicated marginal economic advantage for the Preconcentration as compared with the Base Case variant.

The preconcentration alternative failed to become economically attractive mostly because the savings obtained by processing less material were offset by the higher cost of the dewatering of the various products before and after leaching. The products resulting from the preconcentration process exhibited less favourable conditions for dewatering than those of the Base Case method, due to the concentration of fines and increased water to solids ratios. However, it was believed that the dewatering conditions of the preconcentration products could be significantly improved through systematic testwork, resulting in dewatering rates similar to those given by the Base Case process.

Following this consideration a test program was initiated to study the dewatering of various products in both cases, and to optimize the dewatering

conditions of the preconcentration method, to make this technology eonomically more attractive.

Rio Algom offered to provide the required ore sample for the experiments.

OUTLINE OF INVESTIGATION

A large sample of uranium ore was received from Rio Algom, Quirke mill for this testwork. The chemical composition of the sample was similar to that used in the 1980 laboratory investigation, presented in Report MRP/MSL 80-59 (1).

OBJECTIVES OF THE INVESTIGATION

The objectives of the investigation were:

A. Confirm the results of the 1980 laboratory batch tests, for pyrite flotation and magnetic preconcentration, on a larger sample and in continuous operation (CPDU).

B. Evaluate and compare the metallurgical results obtained by processing low grade uranium ore, prior to leaching, in 2 variants: Base Case (pyrite flotation) and Preconcentration (pyrite flotation and magnetic separation).

C. Evaluate and compare the dewatering rates of the products obtained in the Base Case and Preconcentration variants. Optimize dewatering conditions for the preconcentration technology.

TESTWORK CONDITIONS AND RESULTS

The conditions and results of the testwork are summarized as follows:

Laboratory Versus CPDU Metallurgical Results

The CPDU flowsheet applied to process the ore and to verify the 1980 laboratory results is presented in Fig. 1 and consisted of: crushing, grinding to 42% -200 mesh, pyrite flotation, classification of the flotation tailing at 150 mesh split and magnetic concentration of the two size fractions.

The CPDU operated at a capacity of approximately 50 kg/h for the grinding and flotation circuit.

The metallurgical results of laboratory and CPDU process are compared in Table 1.

Table 1 - Laboratory vs CPDU metallurgical results

Phase	Product	Weight %	Assay				% Distribution			
			S %	U %	Th %	Ra^{226} pCi/g	S	U	Th	Ra^{226}
Lab 1980	Head	100.0	2.64	0.082	0.039	304	100.0	100.0	100.0	100.0
	Pyrite Conc	7.3	33.71	0.300	0.110	1010	93.7	26.7	20.5	24.3
	Mag Preconc	23.8	0.44	0.237	0.114	835	4.0	68.2	68.7	65.1
	Tails(N-Mag)	68.9	0.09	0.006	0.006	47	2.3	5.1	10.8	10.6
CPDU 1981	Head	100.0	2.97	0.079	0.038	270	100.0	100.0	100.0	100.0
	Pyrite Conc	9.6	29.40	0.27	0.091	880	94.8	32.7	23.1	31.3
	Mag Preconc	19.3	0.47	0.25	0.13	784	3.0	60.3	67.4	56.2
	Tails(N-Mag)	71.1	0.09	0.0077	0.0049	47	2.2	7.0	9.5	12.5

Preconcentration Versus Base Case Metallurgical Results

Two variants of the flowsheet were evaluated: Preconcentration (Fig. 1) and Base Case (Fig. 2).

The Base Case represented a variant of the conventional method consisting of pyrite flotation and leaching of the entire flotation tailing while in the Preconcentration variant the flotation tailing was subjected to magnetic separation from which the magnetic preconcentrate only was directed to the leaching process. In both cases the pyrite concentrate was roasted and the calcine was added to the leaching feed.

A comparison of the metallurgical results of the two variants is presented in Table 2 based on the 1981 CPDU testwork.

Table 2 - Metallurgy, Base Case vs Preconcentration

Variant	Product	Weight %	Assay				% Distribution			
			S %	U %	Th %	Ra^{226} pCi/g	S	U	Th	Ra^{226}
Base Case	Head	100.0	2.97	0.079	0.038	270	100.0	100.0	100.0	100.0
	Leach Feed	97.1	0.19	0.082	0.039	278	6.3	100.0	100.0	100.0
	Tails before leach	-	-	-	-	-	-	-	-	-
	Loss by roasting	2.9	-	-	-	-	93.7	-	-	-
Preconcentration	Head	100.0	2.97	0.079	0.038	270	100.0	100.0	100.0	100.0
	Leach Feed	26.0	0.47	0.285	0.130	907	4.2	93.0	90.5	87.5
	Tails before leach	71.1	0.09	0.008	0.005	47	2.1	7.0	9.5	12.5
	Loss by roasting	2.9	-	-	-	-	93.7	-	-	-

Assumed no metal loss in the roasting

Preconcentration Versus Base Case Dewatering Results

Dewatering tests consisting of settling and filter experiments were carried out on products resulting from processing the uranium ore by both Base Case and Preconcentration methods. Since pyrite flotation was applied in both variants under the same conditions, the pyrite dewatering rates obtained in those two technologies were identical. However the other products obtained in the Preconcentration process exhibited worse dewatering rates than the products of the Base Case method. By adding suitable flocculants the dewatering conditions in the Preconcentration variant were optimized and rates similar to those obtained for the Base Case products were achieved.

A comparison of the dewatering optimized results for the 2 variants is presented in Table 3.

Table 3 - Dewatering results, Base Case vs Preconcentration

Product	Base Case						Preconcentration					
	Thickening			Filter			Thickening			Filter		
	Floc g/t	Rate m/h	Area $m^2/t/24h$	Floc g/t	Moist %	Rate $kg/h/m^2$	Floc g/t	Rate m/h	Area $m^2/t/24$ h	Floc g/t	Moist %	Rate $kg/h/m^2$
Pyrite Conc	20	5.5	0.04	50	13	500	20	5.5	0.04	50	13	500
Flot Tails	50	2.4	0.03	-	14	2000	-	-	-	-	-	-
Fine Tailing*	-	-	-	-	-	-	100	2.0	0.10	-	-	-
Preconcentrate	-	-	-	-	-	-	50	12.0	0.03* *	20	16	2000
Leach Slurry	-	-	-	20	15	500	-	-	-	20	16	500

* Prior to magnetic separation the flotation tailing was classified and the fines fraction required thickening before the magnetic concetration.

**Used 0.03 for safety; actual result: 0.02

Figure I. RIO ALGOM ORE PROCESSING PRECONCENTRATION VARIANT

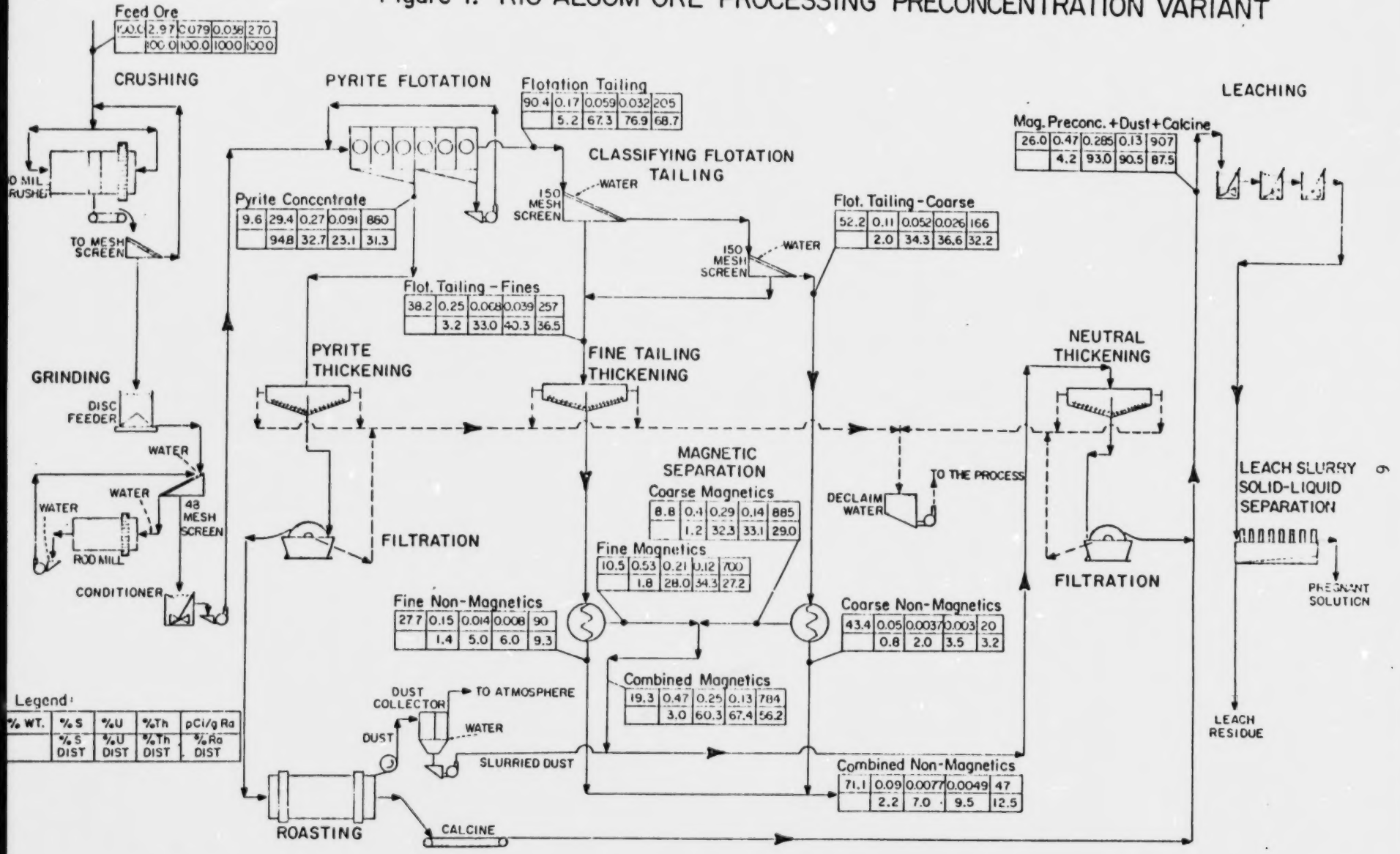
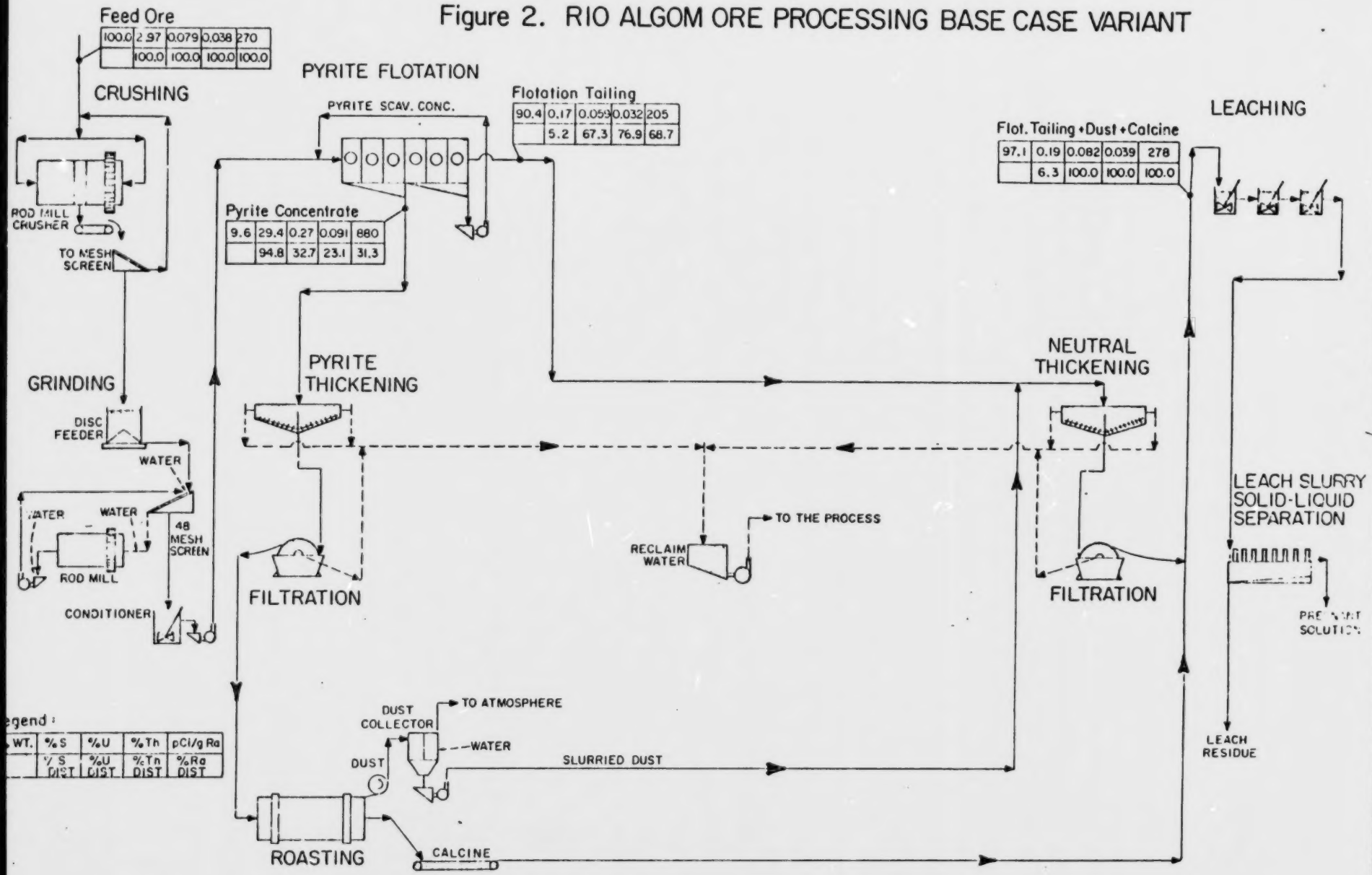


Figure 2. RIO ALGOM ORE PROCESSING BASE CASE VARIANT



CONCLUSIONS

Based on the results of the testwork the following conclusions can be drawn:

a) The CPDU confirmed the laboratory results for both pyrite flotation and magnetic preconcentration.

b) Comparing the metallurgical data of the two variants shows that by applying the Preconcentration technology the material directed to leaching would be reduced, by weight, more than three times and the radioactive metals concentration would be at least three times higher than that of the Base Case. The Preconcentration method would remove tailing of low radioactive concentration but some radionuclides losses before leaching should be expected.

c) The dewatering tests indicated that under certain conditions, it was possible to improve the settling and filtering rates in the Preconcentration process to the extent that they became similar to those of the Base Case variant.

The only difference was that in the Preconcentration variant an extra thickening stage would be required for the fine fraction of the flotation tailing.

Following is an estimate of the total required thickening and filtration area for an assumed 5200 t/24 h operation.

Thickening

	% Weight	t/h	Rate m^2/t/24 h	Req'd Thick. area, m^2	
Base Case					
Flot tails	90.7	196	0.03	141	
Total req'd thickening area					141 m^2
Preconcentration					
Fine tails	38.2	83	0.10	199	
Preconc	19.6	42	0.03	30	
Total req'd thickening area					229 m^2

In the Preconcentration variant an increase in the thickening area of approximately 62%, as compared with the Base Case, will be required.

Filtering

Base Case	% Weight	t/h	Rate $m^2/t/24$ h	Req'd filter area, m^2	
Tails before leach	90.7	196	2000	98	
Tails after leach	97.1	210	500	420	
Total req'd filtering area					518 m^2

Preconcentration	% Weight	t/h	Rate $m^2/t/24$ h	Req'd filter area, m^2	
Preconc before leach	19.6	42	2000	21	
Preconc after leach	26.0	56	500	112	
Total req'd filtering area					133 m^2

In the Preconcentration variant the filter area will be only approximately 26% of the Base Case area, which means a reduction of 74% of the filter area requirement.

Using these data the economics of the two variants can be evaluated and compared on a more realistic basis.

DETAILED DESCRIPTION OF THE TESTWORK

A sample of appoximately 2 tons of uranium ore, crushed to $-\frac{1}{2}$ inch (12.5 mm) was received from Rio Algom for testwork.

The testwork was conducted in two parts:

- In the first part the ore was processed in continuous operation using CPDU equipment.
- The second part consisted of dewatering tests carried out as batch experiments in laboratory scale.

Detailed description of the testwork is further presented.

HEAD ASSAY

The composite of the hourly cuts taken from the feed of the flotation CPDU was used to determine the head assay of the ore sample. The head assay results are given in Table 4.

Table 4 - Head assay

Element	Assay	
	%	pCi/g
S	2.97	-
U	0.083	-
Th	0.042	-
Ra^{226}	-	290

FLOWSHEETS DESCRIPTION

Two variants of flowsheet were analysed and they are tentatively sketched in Fig. 1 and 2. The two flowsheets give the technological concept of the continuous process, from crushing to the stage where the pregnant solution was obtained, although parts of the process (dewatering, roasting) were not performed in continuous operation.

The following technological variants were investigated:

Base Case, consisting of pyrite flotation and leaching of the entire flotation tailing (Fig. 2).

Preconcentration, in which, after the pyrite flotation the tailing was subjected to magnetic separation and then, the magnetic product only was directed to leaching, while the non-magnetics were discarded as final tailing (Fig. 1).

In both cases the pyrite concentrate was roasted and the calcine added to the product going to leaching.

Roasting the pyrite concentrate and the hydrometallurgical part of the process was investigated by EML and is not covered by this report.

Detailed description of the flowsheet for Base Case and Preconcentration is presented.

Base Case. The sequence of the operations in this flowsheet were as follows (Fig. 2):

- Crushing the ore to -10 mesh in a rod mill (dry), operating in closed circuit with a 10 mesh screen.
- Grinding (wet) the ore to approximately 43% -200 mesh in a rod mill operating in closed circuit with a vibrating screen.

- Pyrite flotation, consisting of rougher and scavenger circuits. The rougher concentrate was the final pyrite product while the scavenger concentrate was recirculated to the flotation feed.
- Dewatering the pyrite concentrate by thickening and filter.
- Roasting the pyrite concentrate filter cake. The resultant SO_2 is used to produce H_2SO_4. The calcine is fed, dry, to the leaching units. The dust retained in the dust collectors is slurried and pumped to the flotation tailing before dewatering.
- Dewatering the flotation tailing by thickening and filter.
- Leaching the combined flotation tails, dust and calcine.
- Solid-liquid separation of leach slurry by filtration.

Preconcentration. This flowsheet variant was identical to Base Case as regards the crushing, grinding, pyrite flotation and pyrite roasting. Then the following steps succeeded (Fig. 1):

- Classifying the flotation tails on two -150 mesh vibrating screens operating in series.
- Thickening the -150 mesh fraction prior to magnetic separation.
- Magnetic concentration of the two size fractions treated separately in a high gradient separator. The magnetic product in which the radioactive minerals are concentrated became the preconcentrate, while the non-magnetic product was discarded as final tailing.
- The slurried dust from pyrite roasting joins the combined magnetic product (fine and coarse fractions), after which the preconcentrate is dewatered by thickening and filter.
- Leaching the combined preconcentrate, dust and calcine.
- Solid-liquid separation of leach slurry by filtration.

PROCESSING OF THE URANIUM ORE IN CPDU

The purpose of processing the ore in CPDU was twofold:

a) Confirm on a larger scale and in continuous operation the results of the laboratory batch tests for pyrite flotation and magnetic preconcentration.

b) Collect the required amount of products for roasting, leaching and dewatering tests.

The testwork carried out in CPDU consisted of grinding, pyrite flotation, classifying the flotation tailing and magnetic preconcentration.

Equipment Characteristics

The following pieces of equipment were used for the CPDU testwork:

- Crusher: Marcy center peripheral discharge rod mill 2' x 6' (61 x 183 mm) with 7.5 hp motor. Mill RPM: 30 and the rod charge: 1.4 tons Manufactured by The Mine and Smelter Supply Co., Denver Colorado.
- Screen: Tyler, Ty-Rock virbrating screen 2' x 4' (61 x 122 mm) working in closed circuit with the rod mill crusher.
- Ore disc feeder with hopper, 12 inch (305 mm) diameter, variable speed, ¼ hp motor, used to feed the crushed ore to the grinding circuit.
- Grinding mill: Denver, 12 x 14 inch (305 x 610 mm) rod mill, with 2 hp motor.
  The grinding rod charge consisted of 3 sizes of rods: 1.5; 0.75; 0.5 inch (38; 19; 13 mm, respectively) diameter, for a total weight of 135 lbs (61.3 kg).
- Screen: Sweco, vibrating screen, 30 inch (762 mm) diameter, ½ hp motor, working in closed circuit with the grinding rod mill.
- Conditioner: Denver, 18 x 24 inch (457 x 610 mm) with ½ hp motor.
- Flotation machines: Denver, No-5 Sub. A. Flotation cells, individual drives with ½ hp motor. Capacity: 0.4 cu ft. (10 L) each.
- Screen: Sweco, vibrating screen, 30 inch (762 mm) diameter, ½ hp motor to classify the flotation tailing (first stage).
- Sweeco, vibrating screen, 24 inch (610 mm) diameter, ½ hp motor to classify the flotation tailing (second stage).
- Magnetic separator: Sala high gradient magnetic separator, for laboratory use, Model 10-15-20, manufactured by Sala Magnetics Inc. Cambridge; Massachusetts.

Grinding and Pyrite Flotation

In both variants, Base Case and Preconcentration, grinding of the ore and pyrite flotation took place under the same conditions.

The testwork by CPDU consisted of 4 runs. The first three runs, each lasting up to 4 hours, were carried out to adjust the grinding conditions and the flotation circuits. The required grinding was approximately 43% -200 mesh and the target for the pyrite flotation was to produce a concentrate of 29% S (minimum sulphur content for self roasting) for a recovery in sulphur in excess of 90%.

These requirements were reached under the conditions of run No. 3. Then, run No. 4 was carried out, under the same conditions, for a duration of 18 hours. During this time the pyrite concentrate and the flotation tailing were collected for further testing. Also the circuits were regularly monitored to maintain steady operating conditions and the required samples were periodically taken to evaluate the metallurgical results of the process.

The detailed description of the conditions and results of run No. 4 follow:

Conditions:

Grinding

- Size of the feed ore: -10 mesh
- Feed rate: 40-50 kg/hour
- Mill discharge density: 60% solids (solids specific gravity: 2.6)
- Grinding rod charge: 135 lbs (61 kg)
- Mill rpm: 60
- % critical speed: 77.9
- Screen mesh size: 48

Flotation

- Feed rate: 40-50 kg/hour solids at a flowrate of about 2 L/min slurry
- Fineness of the ore fed to flotation: approximately 43% -200 mesh
- Circuit consisted of 6 Denver Cell No. 5, 3 cells for the rougher flotation and 3 cells for the scavenger flotation
- Densities in the flotation circuit
  Flotation feed: 30% solids
  Rougher and Scavenger flotation: approx. 30% solids
  Pyrite concentrate: approx: 15% solids
  Flotation tailing: 30-33% solids
- Flotation time:
  Rougher flotation: 12 minutes
  Scavenger flotation: 12 minutes
- pH: 8.1
- Temperature: ambient
- Reagents used in the flotation circuits are shown in Table 5

Table 5 - Flotation reagents

Reagent	Function	% Conc	Adding Point	Consumpt. g/t
Z-11 Na isopropyl Xanthate	Collector	1.0	Conditioner	67
			Scaveng. Flot. Cell No. 4	33
			Total	100
Dowfroth 250 Polypropylene glycol ether	Frother	100	Rougher Flot.	40
			Scaveng. Flot. Cell No. 4	40
			Total	80

Results: In run No. 1 and 2 the flotation circuit consisted of 2 rougher flotation cells and 4 scavenger flotation cells. The rougher concentrate (combined froth of cells No. 1 and 2) was the final pyrite product while the scavenger concentrate (combined froth of cells No. 3-6) was recirculated to the flotation feed. Fig. 3 shows the circuit arrangement and the reagent addition.

The assay of the cells froth and the calculated metallurgical results of this circuit arrangement are given in Table 6.

Based on these results it appeared that the froth product of cell No. 3 could be directed to the rougher concentrate since the required grade for the pyrite product was 29% S. Also, the assay of the froth product of cells No. 5 and 6 and that of the flotation tails indicated that more flotation cells are required or an increased amount of collector is needed to meet the over 90% S recovery.

In the next run (No. 3), the circuit was modified by incorporating the cell No. 3 into the rougher flotation and the addition of collector was increased in both conditioning stage and scavenger flotation.

The circuit re-arrangement and the reagents addition of run No. 3 is presented in Fig. 4.

The assay of the cells froth and the metallurgical results of this circuit are given in Table 7.

This circuit arrangement and reagent addition gave satisfactory results as regards to the grade and recovery for total sulphur and therefore it was decided to use it for the final run.

The flotation circuit could probably have been further optimized by eliminating one more cell but the continuation of the investigation in this direction was not considered essential for the purpose of this testwork.

The assay for all elements of interest and metallurgical results of run No. 4 are presented in Table 8. The results of the laboratory test performed in 1980 using the same technology and similar ore are given, for comparison, also in Table 8.

FLOTATION CIRCUITS IN C.P.D.U.

FIG. NO. 3

RUNS NO. 1 AND 2

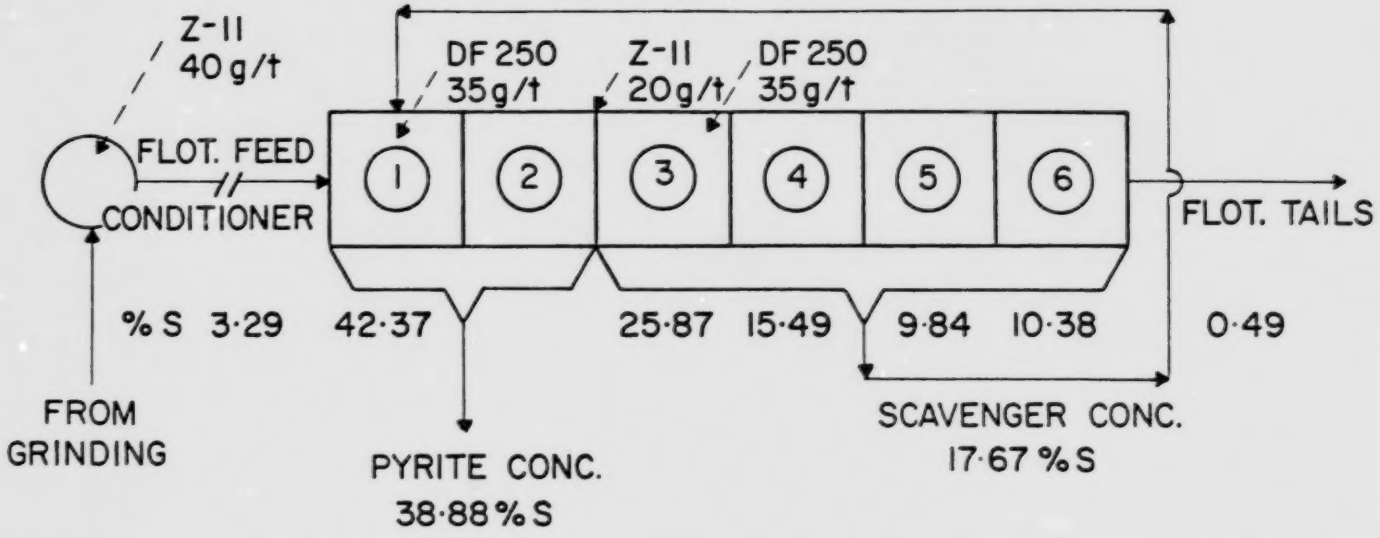


FIG. NO. 4

RUN NO. 3

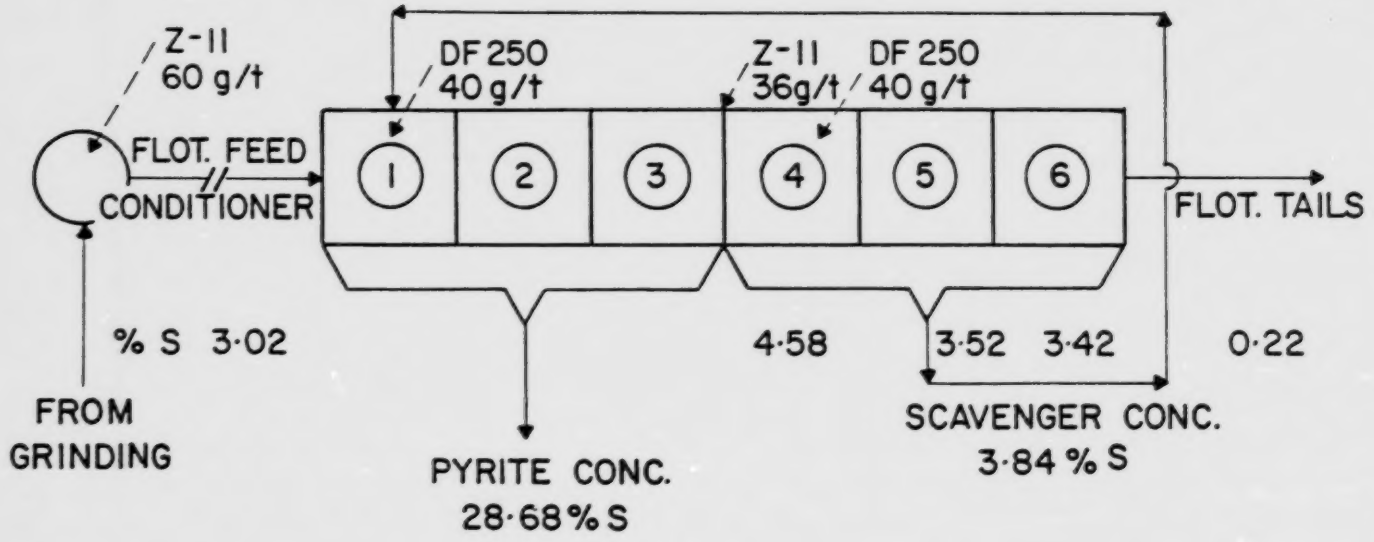


Table 6 - Assays and metallurgical results of CPDU run No. 2

Flot Feed Assay % S	Assay % S, Cell froth					Pyrite Conc Assay, % S	Scav Conc Assay, % S	Flot Tails Assay, % S	Pyrite Conc	
	#1	#3	#4	#5	#6				Wt Yield %	Recovery %
3.29	42.37	25.87	15.49	9.84	10.38	38.88	17.67	0.49	7.3	86.3

Table 7 - Assays and metallurgical results of CPDU run No. 3

Flot Feed Assay % S	Assay % S, Cell froth			Pyrite Conc Assay, % S	Scav Conc Assay, % S	Flot Tails Assay, % S	Pyrite Conc	
	#4	#5	#6				Wt Yield %	Recovery %
3.02	4.58	3.52	3.42	28.68	3.84	0.22	9.8	93.1

Table 8 - Pyrite flotation results (CPDU vs laboratory)

Phase Year	Product	% Wt	Assay				% Distribution			
			S %	U %	Th %	Ra^{226} pCi/g	S	U	Th	Ra^{226}
CPDU 1981	Head	100.0	2.97	0.079	0.038	270	100.0	100.0	100.0	100.0
	Pyrite Conc	9.6	29.40	0.27	0.091	880	94.8	32.7	23.1	31.3
	Flot Tails	90.4	0.17	0.059	0.032	205	5.2	67.3	76.9	68.7
Laboratory 1980	Head	100.0	2.64	0.082	0.039	304	100.0	100.0	100.0	100.0
	Pyrite Conc	7.3	33.71	0.300	0.110	1010	93.7	26.7	20.5	24.3
	Flot Tails	92.7	0.19	0.065	0.033	248	6.3	73.3	79.5	75.7

As can be seen from these data the results of the laboratory testwork were well reproduced in the CPDU. run.

The sieve analysis of the flotation feed, pyrite concentrate and flotation tailing, obtained in the CPDU are given in Table 9.

Table 9 - Sieve analysis of the flotation feed and products

Size		Flotation Feed			Pyrite Concentrate			Flotation Tailing		
Mesh	Microns	% Retained		% Pass Cum	% Retained		% Pass Cum	% Retained		% Pass Cum
		Ind*	Cum**		Ind	Cum		Ind	Cum	
+ 65	210	8.8	8.8	91.2	7.1	7.1	92.9	9.0	9.0	91.0
100	149	20.7	29.5	70.5	20.8	27.9	72.1	20.7	29.7	70.3
150	105	15.5	45.0	55.0	13.4	41.3	58.7	15.7	45.4	54.6
200	74	12.5	57.5	42.5	8.9	50.2	49.8	12.9	58.3	41.7
270	53	7.1	64.6	35.4	5.6	55.8	44.2	7.2	65.5	34.5
400	37	9.3	73.9	26.1	7.5	63.3	36.7	9.5	75.0	25.0
-400	37	26.1	100.0	-	36.7	100.0	-	25.0	100.0	-
Total	-	100.0	-	-	100.0	-	-	100.0	-	-

* Individual
** Cumulative

Classification Of Flotation Tailing

The classification of the flotation tailing took place in the Preconcentration variant only because in this case sizing of the material prior to the magnetic treatment was required for a more efficient separation.

Conditions:
- Screen mesh size: 150 (105 microns)
- Number of screening stages: 2
- Estimated slurry densities:
  - Screening feed: 30% solids
  - Screens undersize (-150 mesh): approx 10% solids
  - Screens oversize (+150 mesh): approx 65% solids
- Estimated screening capacity: 50 $kg/h/m^2$
- Estimated water consumption: approx 140 $L/m^2/h$

In the industrial application the classification of the flotation tailing will most likely be performed by cycloning rather than screening. In that case it is estimated that the slurry density in the cyclone overflow (fine fraction) will be less than 20% solids.

Results: Table 10 gives the sieve analysis of the screening products, which are: the oversize of the second screening stage and the combined undersize of the first and second screening stages.

Table 10 - Sieve analysis of screening products

Size		Undersize (-150 mesh)			Oversize (+150 mesh)		
Mesh	Microns	% Retained		% Pass Cum	% Retained		% Pass Cum
		Ind*	Cum**		Ind	Cum	
+ 65	210	-	-	100.0	14.0	14.1	85.9
100	149	0.5	0.5	99.5	41.0	55.1	44.9
150	105	0.6	1.1	98.9	29.3	84.4	15.6
200	74	7.0	8.1	91.9	14.1	98.5	1.5
270	53	13.9	22.0	78.0	1.3	99.8	0.2
400	37	20.8	42.8	57.2	0.2	100.0	-
-400	37	57.2	100.0	-	-	-	-
Total	-	100.0	-	-	100.0	-	-

* Individual
** Cumulative

The performance of the double stage screening based on 150 mesh split is illustrated in Table 11.

Table 11 - Screening efficiency

Products	% Weight	% Content		% Distribution	
		+150 mesh	-150 mesh	+150 mesh	-150 mesh
Oversize	57.7	84.4	15.6	99.0	17.7
Undersize	42.3	1.1	98.9	1.0	82.3
Screen feed	100.0	49.2	50.8	100.0	100.0

Table 12 - Metallurgical results of flotation tails screening

Phase Year	Screen Product	% Weight		Assay				% Distribution							
								S		U		Th		Ra^{226}	
		Ind*	O/A**	S %	U %	Th %	Ra^{226} pCi/g	Ind	O/A	Ind	O/A	Ind	O/A	Ind	O/A
CPDU 1981	Flot Tails	100.0	90.4	0.17	0.059	0.032	205	100.0	5.2	100.0	67.3	100.0	76.9	100.0	68.7
	Coarse	57.7	52.2	0.11	0.052	0.026	166	37.5	2.0	51.0	34.3	47.6	36.6	46.9	32.2
	Fines	42.3	38.2	0.25	0.068	0.039	257	62.5	3.2	49.0	33.0	52.4	40.3	53.1	36.5
Lab. 1980	Flot Tails	100.0	92.7	0.18	0.065	0.034	249	100.0	6.3	100.0	73.3	100.0	79.5	100.0	75.7
	Coarse	51.0	47.3	0.07	0.057	0.027	198	19.1	1.2	44.5	32.6	40.9	32.5	40.4	30.6
	Fines	49.0	45.4	0.30	0.074	0.041	303	80.9	5.1	55.5	40.7	59.1	47.0	59.6	45.1

* Individual
** Overall

The screens performed with an efficiency of 82.3% for fine material and 99.0% for coarse material.

The assay and distribution of the chemical constituents in the CPDU screening products are presented in Table 12 along with the results of the 1980 laboratory screening.

Magnetic Preconcentration

In the Preconcentration variant the classified flotation tailing was subjected to magnetic preconcentration using a laboratory Sala high gradient separator.

Conditions: The fines (-150 mesh) and coarse (+150 mesh) were treated separately under the following conditions:

Fines

- Matrix: 8
- Flow restrictor: 108 (1.88 L/min)
- Magnetic field: tap 7 or 13.8 K Gauss
- Slurry density:
  - Feed: 10% solids
  - Magnetic product: 14% solids
- Loading: 75 g/cycle

Coarse

- Matrix: 57
- Flow restrictor: 158 (3.7 L/min)
- Magnetic field: tap 7 or 13.8 K Gauss
- Slurry density:
  - Feed: 10% solids
  - Magnetic product: 15% solids
- Loading: 150 g/cycle

Feed slurry of low density (10% solids) was used for the laboratory experiments. For this specific case Sala Magnetics indicated that slurry of 35-40% solids could be used in the industrial application.

The classification of the flotation tailing, by screening or cycloning will result in a fines product of low slurry density (less than 20% solids). Since the capacity of the magnetic units are significantly reduced by a decrease in the slurry feed density (25% capacity reduction for Model 480, when feed density decreases from 30% to 15% solids) it will probably be necessary to thicken the fines product slurry prior to magnetic separation.

The slurry density of the magnetic product (fines and coarse), in the industrial application using Sala equipment, will also be low (approximately 14% solids) due to the substantial addition of water in the rinsing stage.

Results: The metallurgical results of the magnetic separation performed in CPDU are given in Table 13. Also in the same table, for comparison, the results of the laboratory magnetic concentration test carried out in 1980 under similar conditions and using same source of ore are presented.

The sieve analyses of the magnetic separation products are shown in Tables 14 and 15.

Table 13 - Magnetic separation results

Phase Year	Product	% Weight		Assay				% Distribution							
				S %	U %	Th %	Ra^{226} pCi/g	S		U		Th		Ra^{226}	
		Ind*	O/A**					Ind	O/A	Ind	O/A	Ind	O/A	Ind	O/A
CPDU 1981	Coarse Head	100.0	52.2	0.11	0.052	0.026	166	100.0	2.0	100.0	34.3	100.0	36.6	100.0	32.2
	Mags	16.9	8.8	0.40	0.29	0.14	885	61.9	1.2	94.1	32.3	90.5	33.1	90.0	29.0
	Non-Mag	83.1	43.4	0.05	0.0037	0.0030	20	38.1	0.8	5.9	2.0	9.5	3.5	10.0	3.2
	Fines Head	100.0	38.2	0.25	0.068	0.039	257	100.0	3.2	100.0	33.0	100.0	40.3	100.0	36.5
	Mags	27.4	10.5	0.53	0.21	0.12	700	57.1	1.8	84.9	28.0	85.0	34.3	74.6	27.2
	Non-Mag	72.6	27.7	0.15	0.014	0.008	90	42.9	1.4	15.1	5.0	15.0	6.0	25.4	9.3
	Comb. Mags	21.4	19.3	0.47	0.25	0.13	784		3.0		60.3		67.4		56.2
	Comb. Non-Mags	78.6	71.1	0.09	0.0077	0.0049	47		2.2		7.0		9.5		12.5
Lab. 1980	Coarse Head	100.0	47.3	0.07	0.057	0.027	198	100.0	1.2	100.0	32.6	100.0	32.5	100.0	30.6
	Mags	21.4	10.1	0.20	0.260	0.120	890	66.7	0.8	97.2	31.7	94.2	30.6	56.1	29.4
	Non-Mag	78.6	37.2	0.03	0.002	0.002	10	33.3	0.4	2.8	0.9	5.8	1.9	43.9	1.2
	Fines Head	100.0	45.4	0.30	0.074	0.041	303	100.0	5.1	100.0	40.7	100.0	47.0	100.0	45.1
	Mags	30.2	13.7	0.61	0.220	0.110	795	62.8	3.2	89.7	36.5	81.1	38.1	79.2	35.7
	Non-Mags	69.8	31.7	0.160	0.011	0.011	90	37.2	1.9	10.3	4.2	18.9	8.9	20.8	9.4
	Comb. Mags	25.7	23.8	0.44	0.237	0.114	835		4.0		68.2		68.7		65.1
	Comb. Non-Mags	74.3	68.9	0.09	0.006	0.006	47		2.3		5.1		10.8		10.6

* Individual
**Overall

Table 14 - Sieve analysis of magnetic separation products

Size		Coarse Magnetics			Coarse Non-Magnetics			Fines Magnetics			Fines Non-Magnetics		
Mesh	Microns	% Retained		% Pass Cum	% Retained		% Pass Cum	% Retained		% Pass Cum	% Retained		% Pass Cum
		Ind*	Cum**		Ind	Cum		Ind	Cum		Ind	Cum	
+ 65	210	13.5	13.5	86.5	14.9	14.9	85.1	-	-	100.0	-	-	100.0
100	149	36.9	50.4	49.6	36.9	51.8	48.2	-	-	100.0	-	-	100.0
150	105	30.2	80.6	19.4	27.3	79.1	20.9	1.3	1.3	98.7	0.5	0.5	99.5
200	74	15.8	96.4	3.6	17.4	96.5	3.5	10.0	11.3	88.3	8.5	9.0	91.0
270	53	1.9	98.3	1.7	2.1	98.6	1.4	15.7	27.0	73.0	17.0	26.0	74.0
400	37	0.7	99.0	1.0	0.5	99.1	0.9	16.4	43.4	56.6	22.8	48.8	51.2
-400	37	1.0	100.0	-	0.9	100.0	-	56.6	100.0	-	51.2	100.0	-
Total	-	100.0	-	-	100.0	-	-	100.0	-	-	100.0	-	-

*Individual
**Cumulative

Table 15 - Sieve analysis of combined magnetics and non-magnetics

Size		Combined Fines and Coarse Mags			Combined Fines and Coarse Non-Mags*		
Mesh	Microns	% Retained		% Pass Cum	% Retained		% Pass Cum
		Ind	Cum		Ind	Cum	
+ 65	210	6.2	6.2	93.8	9.1	9.1	90.9
100	149	17.8	24.0	76.0	22.5	31.6	68.4
150	105	16.3	40.3	59.7	16.9	48.5	51.5
200	74	14.1	54.4	45.6	13.9	62.4	37.6
270	53	9.5	63.9	36.1	7.9	70.3	29.7
400	37	9.1	73.0	27.0	9.2	79.5	20.5
-400	37	27.0	100.0	-	20.5	100.0	-
Total	-	100.0	-	-	100.0	-	-

*Calculated

METALLURGICAL RESULTS OF THE PROCESS (SUMMARY)

The metallurgical results of both variants: Base Case and Preconcentration are summarized in Table 16 for the CPDU operation and in Table 17 for the 1980 laboratory testwork.

The Base Case consisted of pyrite flotation only, while the Preconcentration involved classification of the flotation tailings and magnetic separation of each size fraction.

In both variants the pyrite concentrate was roasted. The calcine and the dust produced in the roasting were combined with the product directed to leaching.

Therefore for the Base Case the leaching feed consisted of the flotation tailing combined with calcine and dust. No final tailing resulted in this variant prior to leaching.

In the Preconcentration variant the leaching feed consisted of the magnetic preconcentrate combined with calcine and dust. In this variant a final tailing, the non-magnetic product, resulted from the process prior to leaching.

Table 16 - Summary of CPDU metallurgical results:
Base Case and Preconcentration variants

Process	Product	% Weight		Assay				% Distribution							
								S		U		Th		Ra^{226}	
		Ind**	O/A***	S %	U %	Th %	Ra^{226} pCi/g	Ind	O/A	Ind	O/A	Ind	O/A	Ind	O/A
Pyrite Flot	Head	100.0	100.4	2.97	0.079	0.038	270	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Pyrite Conc	9.6	9.6	29.40	0.27	0.091	880	94.8	94.8	32.7	32.7	23.1	23.1	31.3	31.3
	Flot Tails (Calc)	90.4	90.4	0.17	0.059	0.032	205	5.2	5.2	67.3	67.3	76.9	76.9	68.7	68.7
	Flot Tails (assay)			0.24	0.062	0.033	215								
Classification	Flot Tails	100.0	90.4	0.17	0.059	0.032	205	100.0	5.2	100.0	67.3	100.0	76.9	100.0	68.7
	+150 M	57.7	52.2	0.11	0.052	0.026	166	37.5	2.0	51.0	34.3	47.6	36.6	46.9	32.2
	-150 M	42.3	38.2	0.25	0.068	0.039	257	62.5	3.2	49.0	33.0	52.4	40.3	53.1	36.5
Mag Sep Coarse	Head	100.0	52.2	0.11	0.052	0.026	166	100.0	2.0	100.0	34.3	100.0	36.6	100.0	32.2
	+150 M	16.9	8.8	0.40	0.29	0.14	885	61.9	1.2	94.1	32.3	90.5	33.1	90.0	29.0
	Mags	83.1	43.4	0.05	0.0037	0.0030	20	38.1	0.8	5.9	2.0	9.5	3.5	10.0	3.2
	Non-Mags														
Mag Sep Fines	Head	100.0	38.2	0.25	0.068	0.039	257	100.0	3.2	100.0	33.0	100.0	40.3	100.0	36.5
	-150 M	27.4	10.5	0.53	0.21	0.12	700	57.1	1.8	84.9	28.0	85.0	34.3	74.6	27.2
	Mags	72.6	27.7	0.15	0.014	0.008	90	42.9	1.4	15.1	5.0	15.0	6.0	25.4	9.3
	Non-Mags														
Overall Process	Head		100.0	2.97	0.079	0.038	270		100.0		100.0		100.0		100.0
	Pyrite Conc		9.6	29.40	0.27	0.091	880		94.8		32.7		23.1		31.3
	Mags(Calc)		19.3	0.47	0.25	0.13	784		3.0		60.3		67.4		56.2
	Non-Mags(Calc)		71.1	0.09	0.0077	0.0049	47		2.2		7.0		9.5		12.5
	Mags (assay)			0.48	0.27	0.13	795								

Table 16 - Summary of CPDU metallurgical results:
Base Case and Preconcentration variants (cont'd)

	Product	% Weight		Assay				% Distribution							
								S		U		Th		Ra^{226}	
		Ind	O/A	S %	U %	Th %	Ra^{226} pCi/g	Ind	O/A	Ind	O/A	Ind	O/A	Ind	O/A
Base Case	Head		100.0	2.97	0.079	0.038	270		100.0		100.0		100.0		100.0
	Pyrite Calcine		6.4	0.44					1.0						
	Pyrite Dust		0.3	1.07	0.39*	0.13*	1260*		0.1		32.7		23.1		31.3
	Loss by Roast		2.9	–	–	–	–		93.7		–		–		–
	Flot Tail		90.4	0.17	0.059	0.032	205		5.2		67.3		76.9		68.7
	Leach Feed		97.1	0.19	0.082	0.039	278		6.3		100.0		100.0		100.0
Preconcentration	Head		100.0	2.97	0.079	0.038	270		100.0		100.0		100.0		100.0
	Pyrite Calcine		6.4	0.44					1.0						
	Pyrite Dust		0.3	1.07	0.39*	0.13*	1260*		0.1		32.7		23.1		31.3
	Loss by Roast		2.9	–	–	–	–		93.7		–		–		–
	Preconc		19.3	0.47	0.25	0.13	784		3.1		60.3		67.4		56.2
	Non-Mags		71.1	0.09	0.0077	0.0049	47		2.1		7.0		9.5		12.5
	Leach Feed		26.0	0.47	0.285	0.13	907		4.2		93.0		90.5		87.5

* Calculated
** Individual
***Overall

Table 17 - Summary of the 1980 laboratory metallurgical results:
Base Case and Preconcentration variants

Process	Product	% Weight		Assay				% Distribution							
				S	U	Th	Ra^{226}	S		U		Th		Ra^{226}	
		Ind*	O/A**	%	%	%	pCi/g	Ind	O/A	Ind	O/A	Ind	O/A	Ind	O/A
Pyrite Flot (Base Case)	Head	100.0		2.64	0.082	0.039	304	100.0		100.0		100.0		100.0	
	Pyrite Conc	7.3		33.71	0.300	0.110	1010	93.7		26.7		20.5		24.3	
	Flot Tails	92.7		0.19	0.065	0.033	248	6.3		73.3		79.5		75.7	
Classification	Flot Tails	100.0	92.7	0.18	0.065	0.034	249	100.0	6.3	100.0	73.3	100.0	79.5	100.0	75.7
	+150 M	51.0	47.3	0.07	0.057	0.027	198	19.1	1.2	44.5	32.6	40.9	32.5	40.4	30.6
	-150 M	49.0	45.4	0.30	0.074	0.041	303	80.9	5.1	55.5	40.7	59.1	47.0	59.6	45.1
Mag. Sep Coarse	Head														
	+150 M	100.0	47.3	0.07	0.057	0.027	198	100.0	1.2	100.0	32.6	100.0	32.5	100.0	30.6
	Mags	21.4	10.1	0.20	0.260	0.120	890	66.7	0.8	97.2	31.7	94.2	30.6	56.1	29.4
	Non-Mags	78.6	37.2	0.03	0.002	0.002	10	33.3	0.4	2.8	0.9	5.8	1.9	43.9	1.2
Mag Sep Fines	Head														
	-150 M	100.0	45.4	0.30	0.074	0.041	303	100.0	5.1	100.0	40.7	100.0	47.0	100.0	45.1
	Mags	30.2	13.7	0.61	0.220	0.110	795	62.8	3.2	89.7	36.5	81.1	38.1	79.2	35.7
	Non-Mags	69.8	31.7	0.160	0.011	0.011	90	37.2	1.9	10.3	4.2	18.9	8.9	20.8	9.4
Overall Process (Preconcentration)	Head		100.0	2.64	0.082	0.039	304		100.0		100.0		100.0		100.0
	Pyrite Conc		7.3	33.71	0.300	0.110	1010		93.7		26.7		20.5		24.3
	Mags		23.8	0.44	0.237	0.114	835		4.0		68.2		68.7		65.1
	Non-Mags		68.9	0.09	0.006	0.006	47		2.3		5.1		10.8		10.6

* Individual
** Overall

DEWATERING TESTS

The dewatering tests, consisting of settling and/or filter tests were performed in laboratory scale, on various products obtained from the process prior to or after the hydrometallurgical treatment.

Table No 18 indicates the type of dewatering tests performed and how they apply to one or the other flowsheet variants.

Table 18 - Schedule of the dewatering tests

Product Subjected to Dewater	Type of Dewatering Test	
	Base Case	Preconcentration
Pyrite Concentrate	Settling Filter	Settling Filter
Flotation Tailing	Settling Filter	- -
Flot Tails, -150 mesh fraction	-	Settling
Magnetic Preconcentrate	- -	Settling Filter
Leach Residue	Filter	Filter

The settling tests were carried out using the standard laboratory procedure, where the slurry to be investigated is transferred to a graduated one-litre cylinder and the descent of the mudline is recorded and plotted against time. Increased amounts of various flocculants were added to the slurry to improve the settling conditions.

Based on the results of the settling tests, in each case, the settling rate of the slurry was calculated and the required thickening area was evaluated, using the Coe and Clevenger method. This method underestimates thickening unit area, but it was preferred to other ones because of its simplicity, particularly since, the purpose of the test program was to compare the settling characteristics of certain slurry products in those two flowsheet variants, rather than accurately assess the thickening area requirements. For this reason, also, no safety factor was applied in calculating the thickening area to allow for variation in the feed material, temperature, etc.

Batch filter tests were carried out to evaluate the filtration characteristics of the thickened pulp and the slurry resulted from the leaching process.

The filter tests were performed applying the pour-on procedure. A 125-mm diameter Buchner filtration funnel and various types of filter cloths were used. Also, increased amounts of flocculants were added to improve the filter conditions of the pulp. In the case of the leached slurry the washing efficiency was studied under various ratios of water:solids additions.

Based on the test results the filter rates were calculated in each case. No allowance was made for cake discharge in evaluating the total cycle time or for pressure drop in the system, scale-up factor, etc., since again, the purpose of the testwork was rather to compare filter rates of the products from the two flowsheet variants than to accurately size the filter equipment.

Following are presented the conditions and results of the dewatering tests.

Pyrite Concentrate

The pyrite concentrate is subjected to roasting for sulphuric acid production. Prior to roasting the concentrate has to be dewatered to a minimum moisture. Dewatering of the pyrite concentrate is achieved by thickening and filtration (drum, horizontal, belt filter, etc.).

The dewatering tests consisted of settling tests to evaluate the required thickening area and filter test to estimate the filter rates for dry solids and filtrate.

Settling tests: The pyrite concentrate which resulted from the CPDU flotation process had a pulp density of approximately 15% solids, therefore all the settling tests were carried out at this density.

The effect on the settling rates of two flocculants (Separan XD and Superfloc 127) at various consumptions were tried versus no flocculant addition.

The detailed conditions of these settling tests are presented in Appendix A and Fig. A1 and A2.

The results of the settling tests are summarized in Table 19.

Table 19 - Summary of settling test results, Pyrite concentrate

Test No	Flocculant		Slurry Density % Solids		Settling Rate m/h	Thickening Area $m^2/t/24$ h	Supernatant Clarity (Particulates) ppm
	Type	g/t	Initial	Final			
1	-	-	14.9	68.3	1.3	0.169	15
2	Separan XD	10	14.9	63.1	3.1	0.069	not determined
3	Separan XD	20	14.9	59.5	3.3	0.064	not determined
4	Separan XD	50	14.9	61.7	4.3	0.050	6
5	Superfloc 127	10	14.8	63.5	4.7	0.047	not determined
6	Superfloc 127	20	14.9	68.3	5.5	0.040	5
7	Superfloc 127	50	14.8	61.9	7.0	0.031	3

It was considered that the addition of 20 g/t Superfloc 127 would achieve optimum thickening of the pyrite concentrate, conditions under which the final density of the slurry in the compression zone would reach 60-65% solids and the required thickening area would be in the range of 0.04 $m^2/t/24$ h.

The thickener overflow with an estimated clarity below 20 ppm suspended solids could be used as reclaim water in the flotation process.

Filter tests: The filter tests on the pyrite concentrate were carried out under slurry density of 60-62% solids, which can be easily obtained in the thickener underflow as indicated by the settling tests.

A serious difficulty in achieving low cake moisture and high filter rates was encountered under all tested conditions due to the occurence of medium to large cracks during the dry time. To overcome this difficulty the following remedies were tried:

- shorten the form time to reduce the thickness of the filter cake,
- reduce the vacuum from 30 to 20 inch Hg, to limit crack formation,
- use various filter cloths of higher air permeability.

The moisture of the filter cake could not be brought under 13%. This was considered satisfactory for this stage of the testwork but it should be noted that the filtration of the pyrite concentrate would probably deserve some concern later on.

The best filtering conditions were obtained by using a filter cloth with the following specification:

Manufacturer:	EIMCO
Media no:	PO 802 HF (polythene)
Weave:	2/2 Twill
Yarn:	Monofilament
Threads count:	62 x 41
Weight (oz/sq yd):	20.00
Air permeability (cfm/sq ft):	50/80
Finish:	Heat-set

The filter cloth provided by Rio Algom proved to be less suitable than the above for this application.

Various additions of flocculant Percol 455 were tried to improve the filter rates. In a cursory beaker settling test, Percol 455 was selected among other flocculants tried on a small quantity of slurry.

The detailed conditions and results of the filter tests are presented in Appendix B.

A summary of the best conditions and results are given in Table 20.

It can be expected that under 50 g/t Percol 455 addition a filter rate of approximately 500 kg dry solids/h/m^2 will be obtained for a moisture in the range of 13%.

The filtrate, at a rate of 250-300 L/h/m^2 and containing about 0.2% suspended solids can be recirculated to the thickener feed.

Table 20 - Summary of filter test conditions and results

PRODUCT: Pyrite Concentrate

FINENESS: 50% -200 mesh

FILTER CLOTH SPECS: PO 802 HF
Mono-Filament

Test No	Flocculant		Slurry % Solids	Filter Vac (inch Hg)		Filter Time, Sec				Filter Cake			Filtrate	
	Type	g/t		Form	Dry	Form	Dry	Wash	Total Cycle	Thick mm	Rate $kg/h/m^2$	Moisture %	Clarity ppm	Rate $L/h/m^2$
97	-	-	62.2	30	30	97	97	-	194	16	597	13.5	2000	269
98	-	-	62.1	30	30	80	160	-	240	16	486	13.2	2000	223
99	-	-	62.1	30	29	88	264	-	352	16	330	13.2	2000	152
100	Percol 455	50	61.1	30	25	65	65	-	130	16	879	15.1	2000	402
101	Percol 455	50	61.2	30	28	64	128	-	192	16	601	13.4	2000	287
102	Percol 455	50	61.3	30	26	55	165	-	220	16	518	12.8	2000	251
107	Percol 455	100	59.8	29	23	46	92	-	138	16	808	15.1	2000	400
105	Percol 455	100	60.3	29	25	48	144	-	192	16	589	13.4	2000	297

Flotation Tailing

In the Base Case variant only, the flotation tailing goes directly to leaching, but before that is subjected to dewatering, consisting of thickening and filtration, to allow the leaching process to be performed at a high slurry density.

The calcine obtained from pyrite roasting is fed, in a dry form, directly to the leaching vessels. The calcine dust formed in the pyrite roasting is collected in a dust collector from which it is slurried and pumped to the flotation tailing thickener.

Roasting test on pyrite concentrate (29% S) performed by EML, indicated that the dust produced during the roasting represented about 5% of the total roasted product and the weight loss by roasting was about 30%.

It is estimated that the slurried dust coming out of the dust collectors will have a pulp density of about 5% solids.

The relation between the weight of the flotation tailing and the roasting products as well as the pulp densities are shown in Table 21.

Table 21. Evaluating the feed composition of the flotation tailing thickener

Process	Product	% Weight		Slurry % Solids
		Ind*	O/A**	
Flotation	Feed	100.0	100.0	-
	Pyrite Conc	9.6	9.6	-
	Flot Tails	90.4	90.4	-
Roasting	Pyrite Conc	100.0	9.6	-
	Calcine	66.7	6.4	-
	Dust	3.3	0.3	-
	Loss by Roasting	30.0	2.9	-
Thickening	Feed	100.0	90.7	29.6
	Flot Tails	99.7	90.4	30.0
	Slurried dust	0.3	0.3	5.0

* Individual
** Overall

The dewatering tests consisted of settling test to evaluate the thickening area and filter tests to obtain filter rates for dry solids and filtrate.

Settling tests: Settling tests were carried out on the flotation tailing to which the corresponding amount of pyrite roasting dust was added. Also, to determine the effect of the dust addition on the settling characteristics of the tailing, a series of thickening tests were performed without dust addition to the flotation tailings.

Flocculants at various consumptions were used in both cases to improve the settling rates.

The detailed conditions of these settling tests are presented in Appendix C and Fig. C1-C6.

The results of the settling tests on the flotation tailing without dust and with dust addition are summarized in Tables 22 and 23 respectively.

Table 22 - Summary of settling test conditions and results

PRODUCT : Flotation Tailings without Dust

FINENESS: 42% -200 mesh

Test No	Flocculant		Slurry Density % Solids		Settling Rate m/h	Thickening Area $m^2/t/24$ h	Supernatant Clarity (Particulates) ppm
	Type	g/t	Initial	Final			
8	-	-	29.9	66.6	0.5	0.151	5
9	Separan XD	10	29.8	66.0	1.1	0.072	5
10	Separan XD	20	29.8	64.3	1.5	0.052	5
11	Separan XD	50	29.8	64.6	1.6	0.049	5
12	Separan XD	100	29.8	66.0	1.7	0.046	5
13	Superfloc 127	10	29.9	65.2	1.9	0.039	5
14	Superfloc 127	20	29.9	63.5	1.9	0.038	5
15	Superfloc 127	50	29.9	63.3	2.4	0.030	5
16	Superfloc 127	100	29.9	65.1	2.8	0.026	5
17	Superfloc 16	10	29.7	66.2	1.3	0.061	5
18	Superfloc 16	20	29.7	64.0	1.8	0.043	5
19	Superfloc 16	50	29.7	62.0	1.8	0.042	5
20	Superfloc 16	100	29.7	63.6	2.5	0.031	5

Table 23 - Summary of settling test conditions and results

PRODUCT : Flotation Tailing (99.7%) and Pyrite Roasting Dust (0.3%)

FINENESS: 42% -200 mesh

Test No	Flocculant		Slurry Density % Solids		Settling Rate m/h	Thickening Area $m^2/t/24$ h	Supernatant Clarity (Particulates) ppm
	Type	g/t	Initial	Final			
21	-	-	29.9	66.7	0.4	0.200	5
22	Separan XD	10	29.4	65.0	1.0	0.081	5
23	Separan XD	20	29.4	63.9	1.4	0.055	5
24	Separan XD	50	29.4	63.7	1.6	0.048	5
25	Separan XD	100	29.4	64.8	1.7	0.048	5
26	Superfloc 127	10	29.3	65.9	0.7	0.113	5
27	Superfloc 127	20	29.3	63.2	2.1	0.036	5
28	Superfloc 127	50	29.3	61.8	2.1	0.036	5
29	Superfloc 127	100	29.3	60.7	2.4	0.031	5
30	Percol 455	10	29.6	67.4	0.7	0.115	5
31	Percol 455	20	29.6	64.3	2.4	0.032	5
32	Percol 455	50	29.6	63.7	2.4	0.032	5
33	Percol 455	100	29.6	64.0	2.9	0.027	5

The results of these tests showed that the dust addition had some effect on the settling characteristics of the flotation tailing by reducing somewhat the settling rate and increasing the required thickening area. However the changes in the settling rates due to the dust addition were not significant and it is considered that by using approximately 100 g/t flocculant (Superfloc 127 or Percol 455) a settling rate of about 2.4 m/h can be obtained and the required thickening area will be: 0.03 $m^2/t/24$ h. The slurry density in the thickener underflow will exceed 60% solids and the thickener overflow with less than 10 ppm suspended solids could be reused in the flotation process.

Filter tests: The filtration characteristics of the flotation tailing with pyrite roasting dust addition were studied under slurry density of about 60% solids as resulting from the settling tests.

Following are the specifications of the filter cloth used for these tests:

Manufacturer:	Porritts & Spencer
Media no:	5524 Neotex
Fibre type:	88% Nylon staple fibre
	12% Nylon multifilament
Weave:	2/2 Twill
Yarn:	Multifilament
Weight (oz/sq yd):	18.00
Air permeability (cfm/sq ft):	15.0
Finish:	Scoured singed

This filter cloth is used in Rio Algom, Quirke Mill operation.

The target of these filter tests was to achieve high filter rates rather than low moisture, since the filter cake was going to be repulped for the leaching process. Therefore a moisture of 15-20% was considered satisfactory for that purpose.

The detailed conditions and results of the filter tests are presented in Appendix D.

A summary of the most interesting results are given in Table 24.

As can be seen from these data the flotation tailing exhibited good filter rates even under no flocculant addition. A total cycle time of 50 seconds (no allowance for cake discharge and no safety factor applied) gave a dry solids rate in excess of 2000 kg/h/m^2 for a cake moisture of approximately 14%.

The addition of flocculant was used to determine the possibility of increasing the filter rate by flocculation. Filter rates over 2500 dry kg/h/m^2 were obtained, but the form time became very short and therefore the use of such a short submergence would be impractical for some types of filter, because it would involve excessively high number of revolutions per minute for the filtering surface.

Table 24 - Summary of filter test conditions and results

PRODUCT: Flotation Tailing (with dust addition)

FILTER CLOTH SPECS: 5524 Neotex Multi-Filament

FINENESS: 42% -200 mesh

Test No	Flocculant		Slurry % Solids	Filter Vac (inch Hg)		Filter Time, Sec				Filter Cake			Filtrate	
	Type	g/t		Form	Dry	Form	Dry	Wash	Total Cycle	Thick mm	Rate kg/h/m^2	Moisture %	Clarity ppm	Rate L/h/m^2
7	-	-	59.9	30	29	25	25	-	50	18	2073	13.8	1000	1057
5	-	-	60.4	30	29	25	50	-	75	18	1385	12.9	1000	704
6	-	-	60.2	30	28	22	66	-	88	18	1177	12.2	1000	614
8	Percol 455	10	60.0	30	29	20	20	-	40	18	2570	14.9	600	1262
50	Percol 455	10	60.1	30	30	18	36	-	54	18	1887	13.1	600	967
52	Percol 455	10	59.2	30	30	20	60	-	80	18	1262	12.6	600	690
12	Percol 455	20	59.8	30	28	18	18	-	36	18	2862	15.4	600	1402
13-15	Percol 455	20	59.5	29	28	18	36	-	54	18	1912	13.6	600	962
11	Percol 455	20	60.2	30	28	16	48	-	64	18	1619	12.7	600	835

Fine Fraction of Flotation Tailing

In the Preconcentration variant the flotation tailing will be classified into fines (-150 mesh) and coarse (+150 mesh) products.

As was mentioned before, the slurry containing the fines, unlike the coarse product, will require a thickening stage prior to the magnetic separation to allow the magnetic unit to operate at its maximum capacity.

Settling tests: Settling tests were carried out on the fine fraction of the flotation tailing to evaluate the required thickening area for an increase of the slurry density from an assumed 15% solids to 40% solids, the optimum feed density to the Sala separator, as indicated by the manufacturer.

Flocculants were used to improve the settling rates.

The detailed conditions of these settling tests are given Appendix E and Fig. E1 and E2.

The results of the settling tests with the fine fraction of the flotation tailing are summarized in Table 25.

The thickening of this fine material will definitely require some flocculant addition to minimize the thickening area, as indicated by the data of this table.

Table 25 - Summary of settling test conditions and results

PRODUCT: Fine Fraction (-150 mesh) of the Flotation Tailing

FINENESS: 92% -200 mesh

Test No	Flocculant		Slurry Density % Solids		Settling Rate m/h	Thickening Area m^2/t/24 h	Supernatant Clarity (Particulates) ppm
	Type	g/t	Initial	Final			
34	-	-	13.3	40.0	0.36	0.467	2
35	Superfloc 127	20	15.5	40.0	0.42	0.400	1
36	Superfloc 127	50	15.5	40.0	1.0	0.168	1
37	Superfloc 127	100	15.5	40.0	1.6	0.105	1
38	Percol 455	50	15.3	40.0	1.0	0.168	12
39	Percol 455	100	15.3	40.0	2.0	0.084	12

It is considered that a flocculant addition (Superfloc 127 or Percol 455) of about 100 g/t will be needed to thicken the fine fraction of the tailing. Under this condition a settling rate of 1.6-2.0 m/h can be obtained and the required thickening area, for approximately 40% solids in the underflow, will be in the range of 0.1 m^2/t/24 h. The thickener overflow is expected to carry less than 50 ppm suspended solids.

Magnetic Preconcentrate

In the so called "Preconcentration" variant the combined fines (-150 mesh) and coarse (+150 mesh) magnetics representing the preconcentrate, need to be dewatered prior to leaching. The dewatering of the preconcentrate consists of thickening and filtration.

As in the case of the flotation tailing the dust obtained in the pyrite roasting will be slurried and then pumped to the preconcentrate thickener.

The relation between the weight of the preconcentrate and the roasting products as well as the pulp densities are shown in Table 26.

It should be noted that in the case of the preconcentrate, the apportionment of the dust in the thickener feed is much higher than for the flotation tailing thickener.

Settling tests were performed to evaluate the required thickening area and filter tests were carried out to determine the optimum rates for the filter cake and filtrate.

Table 26 - Evaluating the feed composition of the Preconcentrate thickener

Process	Product	% Weight		Slurry % Solids
		Ind*	O/A**	
Flotation and Magnetic Separation	Feed	100.0	100.0	-
	Pyrite Conc	9.6	9.6	-
	Preconc	19.3	19.3	-
	Non-Mags	71.1	71.1	-
Roasting	Pyrite Conc	100.0	9.6	-
	Calcine	66.7	6.4	-
	Dust	3.3	0.3	-
	Loss by Roasting	30.0	2.9	-
Thickening	Feed	100.0	19.6	13.6
	Preconc	98.5	19.3	14.0
	Slurried Dust	1.5	0.3	5.0

* Individual
**Overall

Settling tests: The settling tests were performed using a composite of preconcentrate (98.5% dry weight) and pyrite roasting dust (1.5% dry weight), in a slurry of 13-14% solids. Also, as in the case of the flotation tailing, some settling tests were carried out on preconcentrate without dust, to observe the effect of the fine calcine on the settling characteristics of the magnetic product.

Flocculants at various additions were used in both cases to improve the settling rates.

The detailed conditions of these settling tests are presented in Appendix F and Fig. F1-F7.

The results of the settling tests on the preconcentrate without dust and with dust addition are summarized in Tables 27 and 28 respectively.

The results of these tests indicated that without flocculant addition, the preconcentrate combined with dust exhibited better settling rates than those obtained when no dust was added to it. It is believed that the presence of fine but heavy dust particles has improved the settling conditions of the preconcentrate. In the case of the flotation tailing no improvement of the settling due to dust presence has been noticed, probably because, the addition of dust was to small to induce any favourable thickening effect.

In the presence of flocculants no significant difference in the settling rates for preconcentrate with or without dust addition was observed.

The optimum settling conditions, for the magnetic preconcentrate combined with pyrite roasting dust are considered to be under 50 g/t flocculant (SF 127 or Percol 455) addition, in which case a settling rate of 12-14 m/h can be obtained and the required thickening area will be 0.02 m^2/t/24 h. The slurry density in the thickener underflow will be in the range of 58% solids and the thickener overflow with less than 10 ppm suspended solids could be reused in the process.

It is important to note that although the preconcentrate exhibited less favourable conditions for thickening than the flotation tailing (more fines, lower slurry density), the proper addition of selected flocculants in the preconcentrate succeeded in equalizing and even outperforming the settling results of the flotation tailing (Fig. 5).

Table 27 - Summary of settling test conditions and results

PRODUCT: Preconcentrate without dust

FINENESS: 46% -200 mesh

Test No	Flocculant		Slurry Density % Solids		Settling Rate m/h	Thickening Area m^2/c/24 h	Supernatant Clarity (Particulates) ppm
	Type	g/t	Initial	Final			
40	-	-	14.1	64.4	0.4	0.598	4
41	Separan MG500	20	14.1	59.4	7.2	0.032	4
42	Separan MG500	50	14.1	57.5	7.6	0.030	4
43	Separan MG500	100	14.1	58.8	8.9	0.026	4
44	Superfloc 127	20	14.1	63.0	7.9	0.029	4
45	Superfloc 127	50	14.1	58.4	10.9	0.021	4
46	Superfloc 127	100	14.1	60.0	11.5	0.020	4
47	Superfloc 16	20	14.1	59.4	8.8	0.026	4
48	Superfloc 16	50	14.1	57.7	10.9	0.021	4
49	Superfloc 16	100	14.1	59.0	13.0	0.018	4

Table 28 - Summary of settling test conditions and results

PRODUCT: Preconcentrate (98.5%) and Pyrite Roasting Dust (1.5%)

FINENESS: 46% -200 mesh

Test No	Flocculant		Slurry Density % Solids		Settling Rate m/h	Thickening Area $m^2/t/24$ h	Supernatant Clarity (Particulates) ppm
	Type	g/t	Initial	Final			
50	-	-	13.5	63.5	1.0	0.252	5
51	Separan XD	20	13.5	63.1	2.0	0.122	5
52	Separan XD	50	13.5	61.0	5.8	0.042	5
53	Separan XD	100	13.5	61.5	7.6	0.032	5
54	Superfloc 127	20	13.5	60.6	9.8	0.025	5
55	Superfloc 127	50	13.5	58.2	12.0	0.020	5
56	Superfloc 127	100	13.5	59.1	12.7	0.019	5
57	Percol 455	20	13.5	59.7	9.2	0.026	5
58	Percol 455	50	13.5	58.0	13.7	0.017	5
59	Percol 455	100	13.5	59.7	15.9	0.015	5

Filter tests: The filtration characteristics of the preconcentrate combined with pyrite roasting dust were studied using a slurry density of only 55% solids to be on the safe side since, the settling tests indicated a density of about 60% solids in the compression zone.

The filter cloth used for these tests was the one provided by Rio Algom plant, namely 5524 Neotex, the same that was employed for the flotation tailing filter tests.

In filtering the preconcentrate, as in the case of the flotation tailing, it was intended to obtain high filter rates rather than a low moisture, since the filter cake was to be further repulped for the leaching stage. Moisture of the filter cake in the range of 15-20% was considered acceptable for this purpose.

The detailed conditions and results of the filter tests are presented in Appendix G.

A summary of the most significant results are given in Table 29.

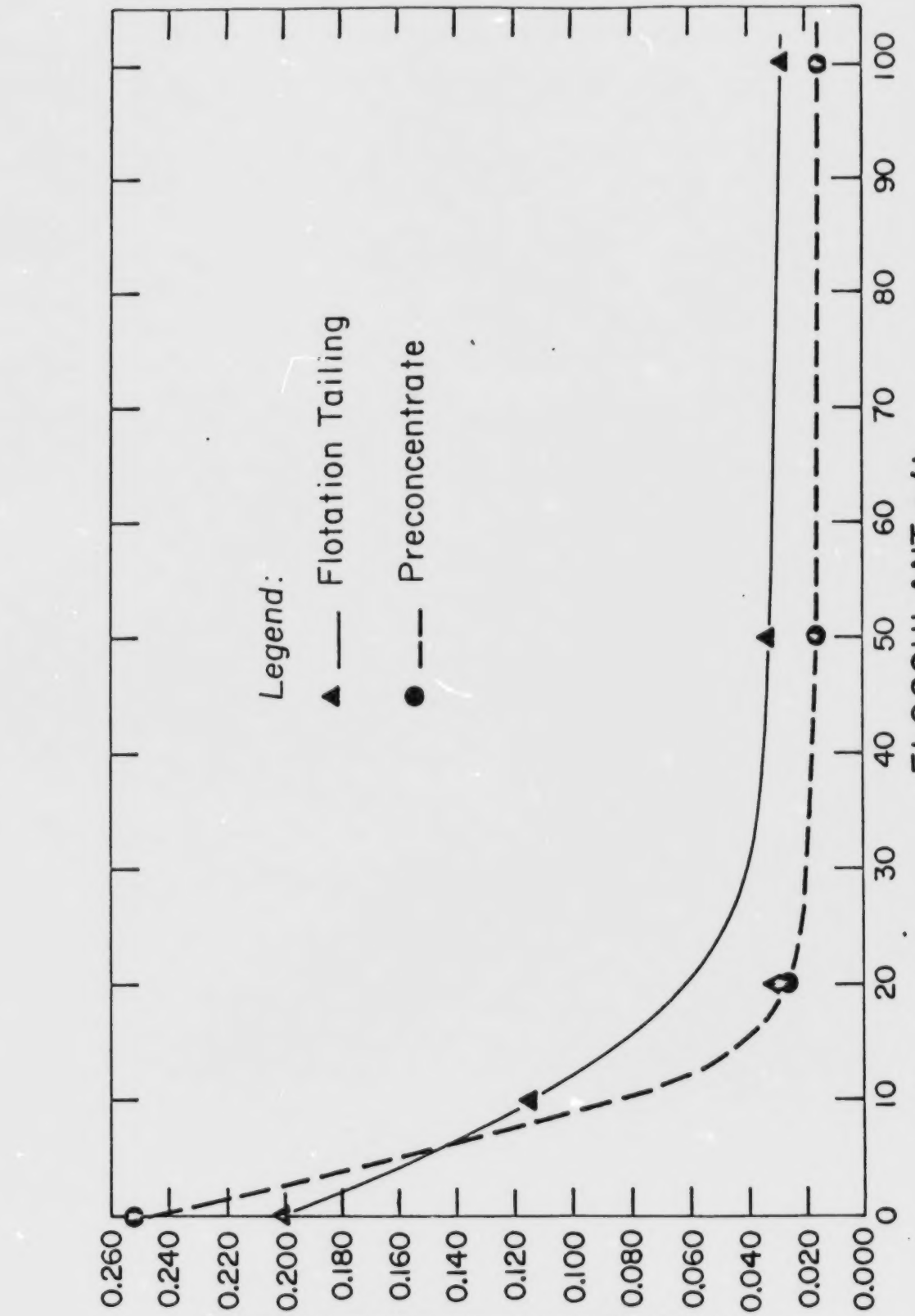


Figure 5 – Thickening area vs flocculant addition. Flotation tailing and Preconcentrate prior to leaching

Table 29 - Summary of filter test conditions and results

PRODUCT: Preconcentrate (with dust addition)

FINENESS: 46% -200 mesh

FILTER CLOTH SPECS: 5524 Neotex
Multi-filament

Test No	Flocculant		Slurry % Solids	Filter Vac (inch Hg)		Filter Time				Filter Cake			Filtrate	
	Type	g/t		Form	Dry	Form	Dry	Wash	Total Cycle	Thick mm	Rate kg/h/m^2	Moisture %	Clarity ppm	Rate L/h/m^2
33	-	-	55.3	30	30	29	29	-	58	18	1747	15.0	110	1103
34	-	-	55.3	30	30	32	64	-	96	18	1058	14.0	110	685
36	-	-	55.6	30	30	30	90	-	120	18	848	13.2	110	548
28	Percol 455	20	54.8	30	30	24	24	-	48	18	2114	16.3	110	1330
32	Percol 455	20	55.6	30	30	23	46	-	69	18	1448	14.1	110	919
37	Percol 455	20	55 1	30	30	25	75	-	100	18	1004	13.8	110	657
27	Percol 455	30	55.4	30	30	20	20	-	40	18	2540	16.1	110	1556
39	Percol 455	30	55.4	30	30	20	40	-	60	18	1616	14.6	110	1027
40	Percol 455	30	54.9	30	30	20	60	-	80	18	1239	13.7	110	822
45	Percol 455	40	54.9	30	30	18	18	-	36	18	2769	16.1	110	1745
42	Percol 455	40	54.9	30	30	18	36	-	54	18	1843	14.7	110	1196
43	Percol 455	40	55.1	30	30	18	54	-	72	18	1385	14.4	110	897
47	Percol 455	50	54.5	30	30	17	17	-	34	18	2905	16.9	110	1830
48	Percol 455	50	54.7	30	30	17	34	-	51	18	1943	15.5	110	1255
49	Percol 455	50	54.5	30	30	16	48	-	64	18	1545	15.0	110	1018

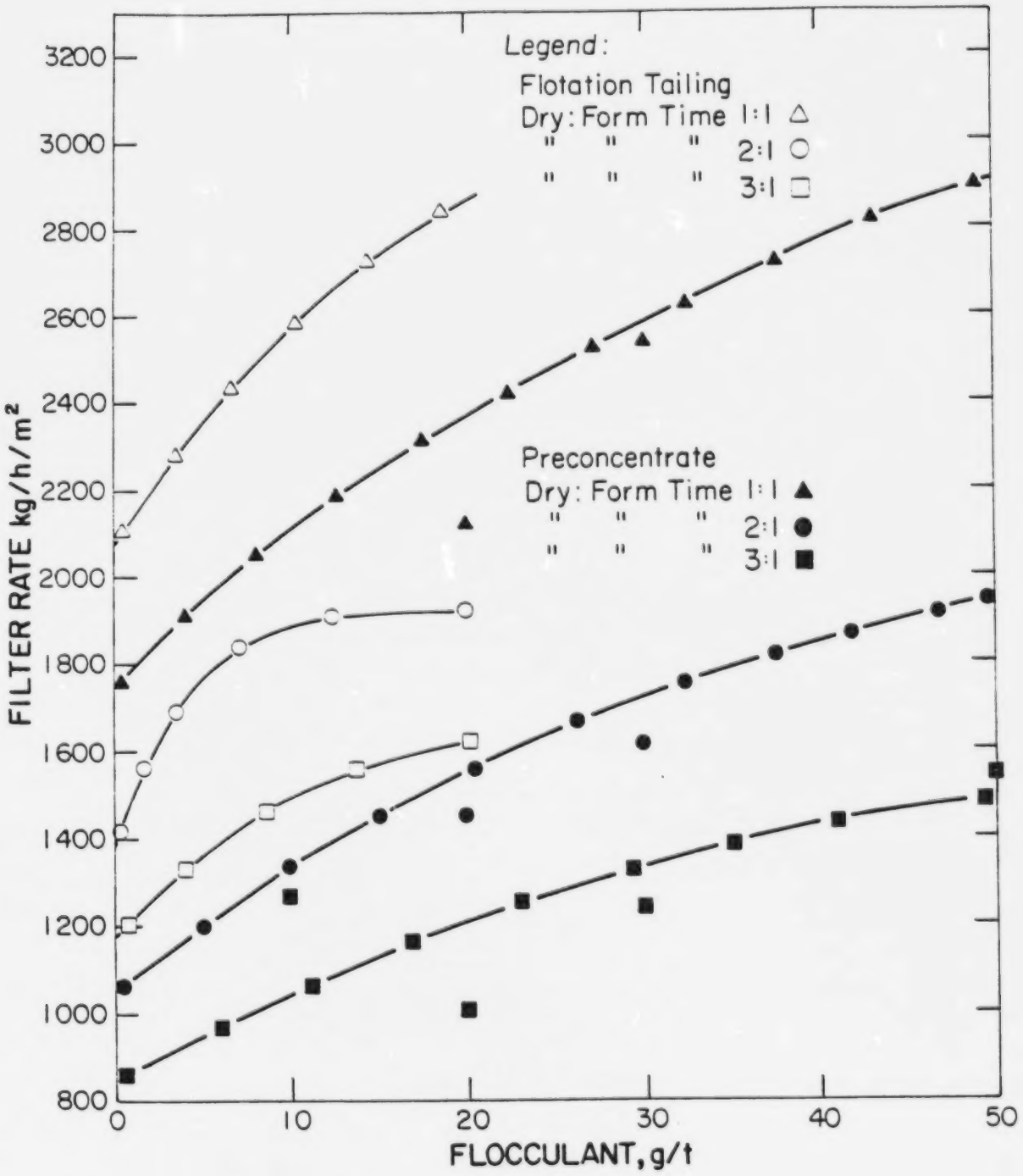


Figure 6 - Filter rates vs flocculant addition under various dry time:form time ratios. Flotation tailing and preconcentrate prior to leaching.

These data indicated that even when no flocculant was used, the preconcentrate showed good filtering behaviour, rates of more than 1700 kg dry solids/h/m^2 being obtained for a moisture of 15%.

To equalize the filtering rates of about 2000 kg/h/m^2 obtained on the flotation tailing, addition of approximately 20 g/t of flocculant (Percol 455) will be required.

Again, as in the case of the thickening process, the preconcentrate exhibited less favourable filtering conditions than the flotation tailing (more fines, lower slurry density), but the addition of proper selected flocculants managed to compensate for this resulting in filter rates and moisture similar to those obtained from the flotation tailing where less flocculant was used (Fig. 6).

Flotation Tailing Leach Slurry

Filter tests: In the Base Case variant, the flotation tailing and pyrite roasting dust was combined after dewatering with pyrite calcine, in a ratio of approximately 9 parts flotation tailing to 1 part calcine and then was subjected to leaching.

After leaching the slurry has to undergo a solid-liquid separation process to separate the pregnant solution from the solids (leach residue). The solid-liquid separation of the leached slurry was studied by filtration.

Following are the specifications of the filter cloth used for these tests:

Manufacturer:	EIMCO
Media no.:	POPR-901 F
Weave:	2/2 TWILL
Yarn:	Multifilament
Threads count:	52 x 35
Weight (oz/sq yd):	13.50
Air Permeability (cfm/sq ft):	6.0
Finish:	Heat-set

The density of the slurry subjected to filtration was approximately 50% solids as resulted from the leaching process. The filter tests were carried out with hot slurry in continuation of the leaching, to avoid possible precipitation or gel formation. The temperature of the slurry was maintained, during the filter test, to about 50°C, a drop of approximately 20 degrees from the 70°C leaching temperature, to allow for loss of heat between leaching and filter stages.

A flocculant, Superfloc 127 was used to shorten the form time and to improve the filter rates. Beaker test carried out with few flocculants including Percol 455 indicated a slight advantage in favour of SF. 127.

Dry time in a ratio of 1:1; 2:1 and 3:1 to the form time was used to determine its effect on the cake moisture.

A washing stage was applied to reduce the radioactive metals losses in the filter cake. Wash water to solids ratios of 1:1; 0.75:1; 0.5:1 and 0.25:1 (by weight) were investigated and in each case the washing efficiency for U, Th and Ra^{226} was evaluated. Acidified water (HCl solution) was used as wash water.

The detailed conditions and results of the filter test are given in Appendix H.

A summary of the filter tests results is presented in Table 30.

Without flocculant addition the filter rates varied between approximately 100 and 230 kg dry solids/h/m^2 with moisture content of about 13%. The best washing efficiency was achieved for 0.75:1 ratio, water to solids.

The flocculant addition significantly improved the filter rates, which increased to 500 kg/h/m^2 or even higher. However, in the presence of flocculant the moisture increased also and the washing was in some cases not so efficient. It is likely that the flocs formation prevented good drainage of the water and efficient washing of the filter cake.

The following conditions are considered optimum for filtering the leach slurry of combined flotation tailing and calcine:

Flocculant:	SF. 127, 20 g/t
Total filter time (form, dry, washing):	approximately 170 seconds
Washing ratio:	0.75-0.5:1 water to solids, by weight

Under these conditions a filter rate of approximately 500 kg/h/m^2 was obtained for a cake moisture of about 15%.

Table 80 - Summary of filter test conditions and results

PRODUCT: Leach Slurry of Combined Flotation Tailing (90%) and Pyrite Calcine (10%)

FINENESS: 44% -200 mesh

FILTER CLOTH SPECS: POPR-901 F from EIMCO

Test No	Flocculant		Slurry % Solids	Filter Vac (inch Hg)		Filter Time, Sec.				Filter Cake			Filtrate		Wash Water		Washing Efficiency, %		
	Type	g/t		Form	Dry	Form	Dry	Wash	Total	Thick mm	Rate kg/h/m²	Moisture %	Clarity ppm	Rate L/h/m²	Ratio water:solids	Rate L/h/m²	U	Th	Ra^{226}
112	-	-	45.1	30	30	65	130	440	635	15	111	18.1	50	233	1.00:1	138	88.1	85.0	-
117	-	-	51.5	30	30	57	171	353	581	15	148	12.7	50	196	0.75:1	113	-	98.3	96.2
111	-	-	48.0	30	30	70	140	205	415	14	185	11.4	50	251	0.50:1	106	91.2	81.2	96.8
114	-	-	50.7	30	30	62	186	93	341	15	234	12.1	50	233	0.25:1	64	87.5	87.7	65.4
122	S.F. 127	10	55.6	30	30	50	100	360	510	16	171	19.8	50	209	0.75:1	129	99.2	95.6	91.4
121	S.F. 127	11	52.6	30	30	42	84	163	289	15	280	19.1	50	300	0.50:1	152	84.5	89.1	75.5
123	S.F. 127	11	54.5	30	30	41	82	59	182	16	456	16.4	50	378	0.25:1	121	89.7	86.8	51.3
125	S.F. 127	20	54.5	30	30	25	50	92	167	15	521	15.6	50	684	0.75:1	394	93.7	88.5	77.0
124	S.F. 127	22	51.9	30	30	31	62	77	170	16	473	14.7	50	575	0.50:1	258	80.8	94.1	69.5
119	S.F. 127	27	50.9	30	30	25	25	57	107	16	752	16.7	50	990	0.50:1	410	91.6	59.8	89.2

The washing efficiency was satisfactory in most of the cases and it is believed that it can be improved by applying more washing stages at various water to solids ratio.

The sieve analysis of the leach residue obtained from these filter tests is given in Table 31.

Table 31 - Sieve analysis of the leach residue (flotation tailing and calcine)

Size		% Retained		% Pass Cum
Mesh	Microns	Ind*	Cum**	
+ 65	210	5.0	5.0	95.0
100	149	18.0	23.0	77.0
150	105	19.5	42.5	57.5
200	74	14.5	57.0	43.0
270	53	10.2	67.2	32.8
400	37	9.3	76.5	23.5
-400	37	23.5	100.0	-
Total	-	100.0	-	-

* Individual
**Cumulative

Magnetic Preconcentrate Leach Slurry

Filter tests: In the "Preconcentration" variant, the magnetic preconcentrate (fines and coarse) and the pyrite roasting dust was combined after dewatering with pyrite calcine, in a ratio of approximately 2 parts preconcentrate and 1 part calcine and then was subjected to leaching.

After leaching the slurry underwent the solid-liquid separation which as in the case of the flotation tailing was studied by filtration.

The filter cloth used for these filter tests was the same as that for the flotation tailing, namely EIMCO, POPR-901 F.

The density of the slurry subjected to filtration was approximately 50% solids as resulted from the leaching tests. The filter tests were carried out immediately after the leaching process, at a temperature of 50°C, an approximative drop of 20° from the leaching temperature, to allow for heat loss between process steps.

Flocculant Superfloc 127 was selected to be used, to shorten the form time and improve the filter rates.

Dry time in a ratio of 1:1, 2:1; and 3:1 to the form time was tried.

In the washing stage ratios of 1:1; 0.75:1; 0.5:1 and 0.25:1 wash water to solids (by weight) were investigated and in each case the washing efficiency for U, Th and Ra^{226} was evaluated. Acidified water (HCl solution) was used as wash water.

The detailed conditions and results of the filter tests are given in Appendix I and a summary of the filter test results is presented in Table 32.

Without flocculant addition the filter rates were quite low (100 - 165 kg/h/m^2) and the cake moisture was high (18-22%).

With the increased addition of flocculant the filter rates for dry solids improved drastically reaching over 500 kg/h/m^2 for cake moisture in the range of 16%. The washing efficiency was quite good throughout the tests and it could probably be further improved by applying more washing stages.

The following conditions are considered optimum for filtering the combined magnetic preconcentrate and calcine:

Flocculant:	S.F. 127. approx. 20 g/t
Total filter time (form, dry, washing):	approximately 170 seconds
Washing ratio:	0.75-0.5:1 water to solids by weight

Under these conditions a filter rate of approximately 500 kg/h/m^2 was obtained for a cake moisture of about 16%.

Table 42 - Summary of filter test conditions and results

PRODUCT: Leach Slurry of Combined Preconcentrate (66.7%) and Pyrite Calcine (33.3%)

FINENESS: 45% -200 mesh

FILTER CLOTH SPECS: POPR 901 P
from EIMCO

Test No	Flocculant		Slurry % Solids	Filter Vac (Inch Hg)		Filter Time, Secs.				Filter Cake			Filtrate		Wash Water		Washing Efficiency %	
	Type	g/t		Form	Dry	Form	Dry	Wash	Total	Thick mm	Rate kg/h/m²	Moisture %	Clarity ppm	Rate l/h/m²	Ratio water:solids	Rate l/h/m²	D	Th
126		-	48.7	30	30	120	240	465	825	15	96	17.9	50	116	0.50:1	54	97.1	91.8
127		-	49.9	30	30	120	120	257	497	16	165	22.0	50	141	0.25:1	44		88.8
130	S.F. 127	11	49.8	30	30	55	110	165	330	16	244	18.4	50	159	0.75:1	200	-	93.6
141	S.F. 127	11	50.0	30	30	75	75	155	305	15	268	20.2	50	305	0.50:1	144	95.9	97.3
131	S.F. 127	11	50.3	30	30	60	120	60	240	15	332	16.6	50	115	0.25:1	92	94.7	90.8
134	S.F. 127	19	51.0	30	30	42	84	83	209	16	377	15.9	50	462	0.50:1	210	96.2	-
139	S.F. 127	22	50.2	30	30	34	34	100	168	15	478	17.6	50	711	0.75:1	192	97.5	99.6
135	S.F. 127	22	50.2	30	30	15	70	60	165	16	486	15.8	50	601	0.50:1	266	93.9	93.1
137	S.F. 127	22	49.4	30	30	12	64	28	124	15	652	15.4	50	650	0.25:1	177	97.0	91.1
129	S.F. 127	29	50.4	30	30	20	40	50	110	15	746	17.3	50	915	0.50:1	399	96.3	94.1

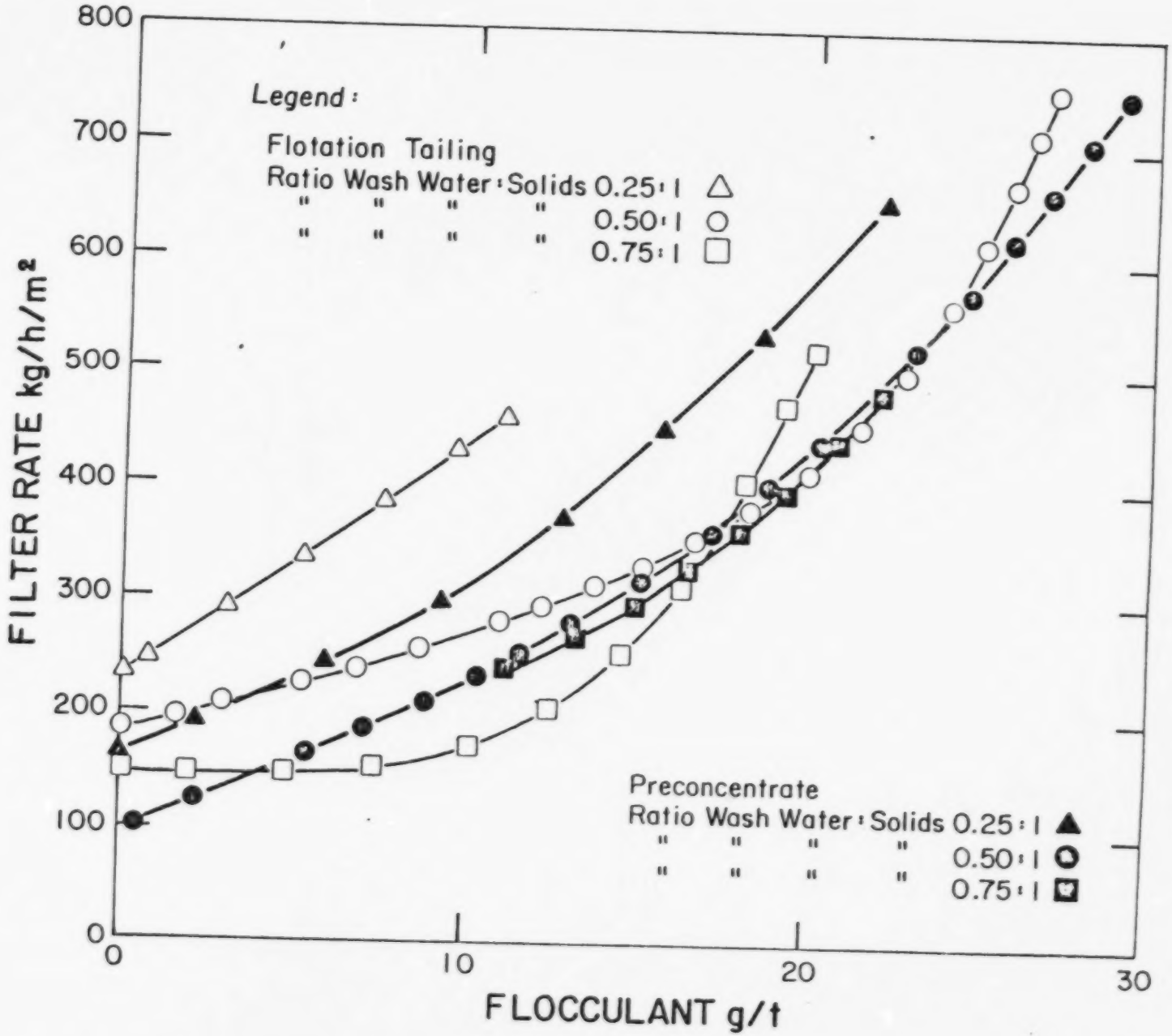


Figure 7 - Filter rates vs flocculant addition under various ratios of wash water: solids. Flotation tailing and preconcentrate leach pulps.

The sieve analysis of the leach residue obtained from these filter tests is shown in Table 33.

Table 33 - Sieve analysis of the leach residue (preconcentrate and calcine)

Size		% Retained		% Pass Cum
Mesh	Microns	Ind*	Cum**	
+ 65	210	4.0	4.0	96.0
100	149	12.0	16.0	84.0
150	105	17.5	33.5	66.5
200	74	21.5	55.0	45.0
270	53	3.7	58.7	41.3
400	37	7.3	66.0	34.0
-400	37	34.0	100.0	-
Total	-	100.0	-	-

* Individual
**Cumulative

In the absence of flocculant the filter results of the preconcentrate leach slurry were inferior to those of the flotation tailing leach slurry. However, under the flocculant addition both leach residues responded quite similar to filtration, giving filter rates and moisture values within very close range (Fig. 7).

ACKNOWLEDGEMENTS

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REFERENCE

1. D. Raicevic and M. Raicevic "Preconcentration of uranium ores yielding tailings of greatly reduced environmental concern. Part IV - Elliot Lake ore - 0.084% U."; Division Report MRP/MSL 80-59 (IR); CANMET, Energy, Mines and Resources Canada; 1980.

APPENDIX A

PYRITE CONCENTRATE
SETTLING TESTS 1-7

SETTLING TEST REPORT

Pyrite Concentrate

Test #1

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	50	132
2	900	60	130
3	830	70	129
4	780	80	128
5	720	90	127
6	660	100	127
7	560	170	123
8	510	200	122
9	450	230	122
10	390	260	122
11	320	290	122
12	250	320	122
13	205	1290	122
14	190	1350	122
15	180		
16	170		
18	160		
20	155		
30	142		
40	137		

FLOCCULANT: None

Solids S.G.: 3.9

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1746.8 g
CYL. EMPTY	623.5 g
SLURRY	1123.3 g

Solids: 165.5 g (dry)

SLURRY DENSITY: 14.9%

SETTLING TEST REPORT

Pyrite Concentrate

Test #2

Time Min	Mudline mL column	Time Min	Mudline mL column
0	990	16	185
½	940	18	180
1	820	20	177
1½	700	25	169
2	570	30	162
2½	440	35	159
3	330	40	155
3½	290	45	151
4	271	50	150
4½	257	55	149
5	249	60	148
6	234	130	140
7	225	180	138
8	219	240	138
9	211	1440	135
10	206		
11	201		
12	198		
13	194		
14	190		

FLOCCULANT: Separan XD 10 g/t

Solids S.G.: 3.9

TEMPERATURE: 20°C

WEIGHT
CYL. + SLURRY 1752.8 g
CYL. EMPTY 634.4 g
SLURRY 1118.4 g

Solids: 166.3 g (dry)

SLURRY DENSITY: 14.9 % solids

SETTLING TEST REPORT

Pyrite Concentrate

Test #3

Time Min	Mudline mL column	Time Min	Mudline mL column
0	980	18	178
30 sec	850	20	173
1	670	25	165
1½	520	30	160
2	360	35	158
2½	310	40	155
3	285	45	152
3½	270	50	150
4	256	55	150
5	240	60	149
6	230	75	147
7	220	90	145
8	213	105	143
9	208	120	142
10	201	180	141
11	198		
12	193		
13	190		
14	188		
16	181		

FLOCCULANT: Separan XD 20 g/t

Solids S.G.: 3.9

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1752.8 g
CYL. EMPTY	634.4 g
SLURRY	1118.4 g

Solids: 166.3 g (dry)

SLURRY DENSITY: 14.9 % solids

SETTLING TEST REPORT

Pyrite Concentrate

Test #4

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	18	171
¼	740	20	170
1	550	25	165
1¼	390	30	161
2	325	35	160
2¼	290	40	159
3	270	45	158
3¼	261	50	157
4	248	55	157
5	230	60	156
6	218	75	155
7	209	120	152
8	200	135	151
9	195	150	151
10	190	165	151
11	188		
12	183		
13	180		
14	178		
16	174		

FLOCCULANT: Separan XD 50 g/t

Solids S.G.: 3.9

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1752.8 g
CYL. EMPTY	634.4 g
SLURRY	1118.4 g

SLURRY DENSITY: 14.9 % solids

Solids: 166.3 g (dry)

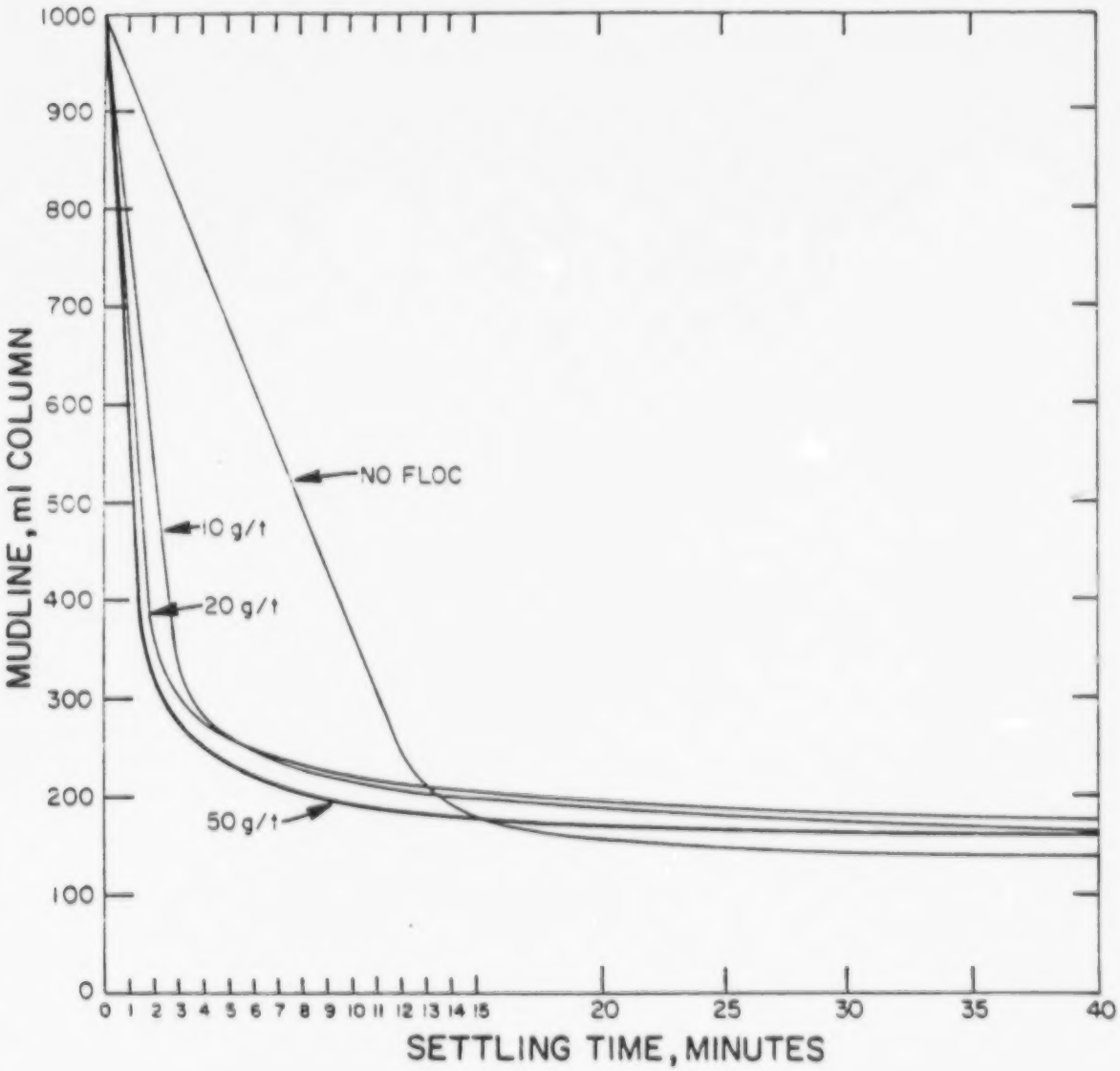

Figure A1 - Settling tests: Pyrite concentrate, Separan XD vs no flocculant

SETTLING TEST REPORT

Pyrite Concentrate

Test #5

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	20	169
¼	930	25	161
1	800	30	158
1¼	500	35	155
2	310	40	152
2¼	260	70	145
3	248	90	142
4	230	105	142
5	220	120	142
6	211	1080	136
7	205	1140	136
8	200		
9	195		
10	190		
11	188		
12	184		
13	180		
15	178		
17	172		
18	170		

FLOCCULANT: S.F. 127 — 10 g/t — Solids S.G.: 3.9

TEMPERATURE: 20°C

WEIGHT — CYL. + SLURRY: 1802.8 g; CYL. EMPTY: 676.5 g; SLURRY: 1126.3 g — Solids: 166.6 g (dry)

SLURRY DENSITY: 14.8 % solids

SETTLING TEST REPORT

Pyrite Concentrate

Test #6

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1010	20	165
½	920	22	163
1	600	24	160
1½	350	26	159
2	270	28	158
2½	250	30	157
3	240	40	155
4	224	50	154
5	212	120	145
6	205	150	145
7	192	180	144
8	189	210	144
9	185	240	143
10	180	270	143
11	178	1240	131
12	176		
13	172		
15	170		
16	169		
18	167		

FLOCCULANT: S.F. 127 (1 g/ℓ) 20 g/t

Solids S.G.: 3.9

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1787.9 g
CYL. EMPTY	663.8 g
SLURRY	1124.1 g

Solids: 167.5 g (dry)

SLURRY DENSITY: 14.9 % solids

SETTLING TEST REPORT

Pyrite Concentrate

Test #7

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1010	30	164
½	680	35	164
¾	450	40	163
¼	320	45	162
1	280	50	162
1½	240	60	162
2	220	90	160
2½	209	165	160
3	200	240	159
4	190	300	159
5	184	1440	155
6	180		
8	175		
10	171		
12	170		
14	169		
16	169		
18	168		
20	168		
25	165		

FLOCCULANT: S.F. 127 — 50 g/t — Solids S.G.: 3.9

TEMPERATURE: 20°C

WEIGHT	CYL. + SLURRY	1787.9 g	
	CYL. EMPTY	663.8 g	
	SLURRY	1124.1 g	Solids: 166.6 g (Dry)
SLURRY DENSITY:	14.8 % solids		

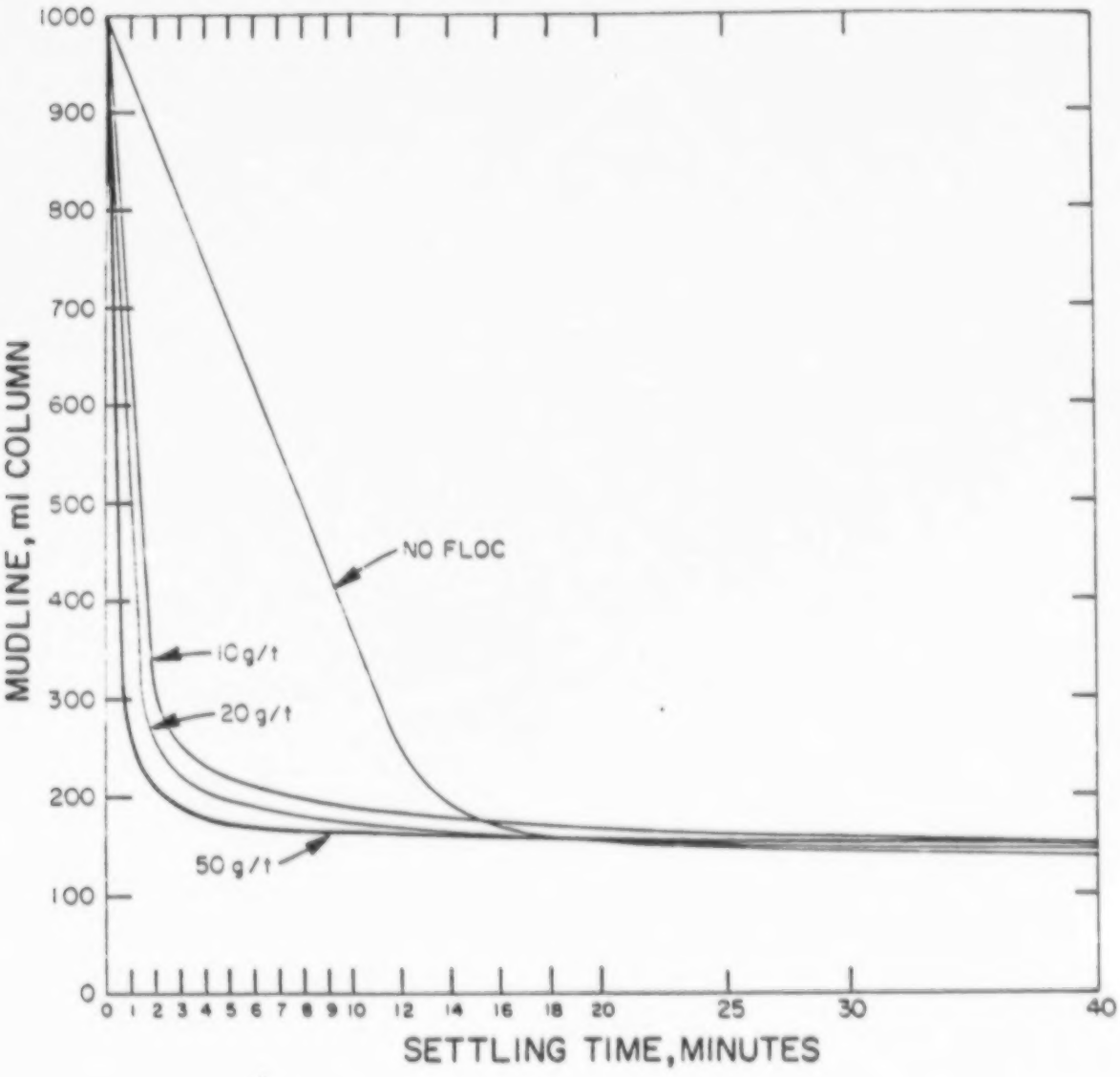

Figure A2 - Settling tests: Pyrite concentrate, Superfloc 127 vs no flocculant

APPENDIX B

PYRITE CONCENTRATE
FILTER TESTS 55-109

Characteristics of the cloth used on Pyrite Concentrate filter tests

Manufacturer	Porritts & Spencer	EIMCO	EIMCO
Media No	5524 Neotex	PO 802 HF	NY 527 F
Fibre type	88% Nylon Staple fibre 12% Nylon Multifilament	Polythene	Nylon
Weave	2/2 TWILL	2/2 TWILL	2/2 TWILL
Yarn	Multifilament	Monofilament	Monofilament
Threads Count	-	62 x 41	157 x 62
Weight (oz./sq. yd)	18.00	20.00	5.75
Air permeability (cfm/sq. ft)	15.0	50/80	176.0
Finish	Scoured singed	Heat set	Calendered

FILTER TEST REPORT

TEST CONDITIONS — Pyrite Concentrate

FILTER CLOTH SPECS. 5524 Neotex from Porritts & Spencer

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.		
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Total Cycle
55	-	-	59.9	3.7	22	30	30	55	55	110
56	-	-	60.1	3.7	22	30	28	60	120	180
57	-	-	60.7	3.7	22	30	28	50	150	200
58	Percol 455	10	60.4	3.7	22	30	30	52	52	104
59	Percol 455	50	59.3	3.7	22	30	27	38	38	76
60	Percol 455	75	59.5	3.7	22	30	27	27	27	54
61	Percol 455	50	59.4	3.7	22	30	25	42	84	126
62	Percol 455	50	39.7	3.7	22	30	28	40	120	160
63	Percol 455	75	59.3	3.7	22	30	25	29	58	87

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA		
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry $kg/h/m^2$	Volume mL	Clarity particulates ppm	Rate $L/h/m^2$
			Wet	Dry					
55	1	16	458.9	391.0	14.8	1043.2	194	500	517.6
56	3	16	462.6	395.8	16.9	645.4	196	500	319.6
57	1	16	461.8	400.7	15.2	588.0	198	500	290.6
58	5	16	464.1	393.8	17.9	1111.3	188	500	530.5
59	2	16	461.0	388.2	18.8	1499.1	194	500	749.2
60	4	16	463.0	390.7	18.5	2123.5	194	500	1054.4
61	6	16	456.8	387.9	15.1	903.5	196	500	456.5
62	8	16	445.9	383.2	16.4	702.9	196	500	359.5
63	7	16	454.5	386.7	17.5	1304.5	198	500	668.0

FILTER TEST REPORT

TEST CONDITIONS — Pyrite Concentrate

FILTER CLOTH SPECS. 5524 Neotex from Porritts & Spencer

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.		
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Total Cycle
64	-	-	62.4	3.7	22	30	30	32	32	64
65	-	-	62.3	3.7	22	30	29	38	76	114
66	-	-	62.2	3.7	22	29	28	45	135	180
67	-	-	61.4	3.7	22	29	28	47	47	94
68	-	-	62.2	3.7	22	28	28	37	74	111
69	-	-	61.8	3.7	22	29	28	47	141	188
70	-	-	62.1	3.7	22	20	20	47	47	94
71	-	-	61.9	3.7	22	25	25	67	67	134
72	-	-	62.1	3.7	22	22	21	58	58	116

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA		
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry	Volume mL	Clarity particulates ppm	Rate L/h/m²
			Wet	Dry		kg/h/m²			
64	5	14	403.2	347.7	13.8	1594.5	154	500	706.2
65	3	14	402.4	347.8	13.6	895.4	156	500	401.6
66	4	14	401.8	347.0	13.6	565.8	156	500	254.4
67	2	12	342.1	292.2	14.6	912.3	134	500	418.4
68	4	12	341.2	295.4	13.4	781.1	134	500	354.3
69	10	12	343.2	295.0	14.0	460.5	134	500	209.2
70	None	14	405.2	343.5	15.2	1072.5	148	500	462.1
71	3	14	405.3	346.2	14.6	758.3	154	500	337.3
72	2	14	407.4	346.1	15.0	875.7	150	500	379.5

FILTER TEST REPORT

TEST CONDITIONS Pyrite Concentrate

FILTER CLOTH SPECS. 5524 Neotex from Porritts & Spencer

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.		
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Total Cycle
73	-	-	62.4	3.7	22	20	20	55	55	110
74	-	-	61.6	3.7	22	20	20	75	225	300
75	-	-	61.7	3.7	22	20	20	80	240	320
76	-	-	61.6	3.7	22	20	20	55	165	220
77	-	-	61.5	3.7	22	25	25	38	114	152
78	-	-	61.9	3.7	22	23	23	55	165	220
79	-	-	61.9	3.7	22	30	28	42	42	84
80	-	-	61.7	3.7	22	25	24	35	35	70
81	-	-	61.3	3.7	22	20	20	33	99	132

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA		
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry $kg/h/m^2$	Volume mL	Clarity particulates ppm	Rate $L/h/m^2$
			Wet	Dry					
73	2 small	16	466.9	396.1	15.2	1056.8	168	500	448.2
74	3	16	463.1	394.0	14.9	385.5	176	500	172.2
75	2	14	407.1	346.3	14.9	317.6	154	500	141.2
76	-	12	340.0	291.9	14.1	389.4	134	500	178.8
77	2 small	12	340.6	294.4	13.6	568.5	138	500	266.5
78	1 small	12	343.8	296.9	13.6	396.1	136	500	181.4
79	1 lg, 1 md	10	285.3	244.5	14.3	854.3	110	500	384.3
80	1 large	10	288.7	245.9	14.8	1031.0	110	500	461.2
81	1 lg,1 sml	10	284.7	244.3	14.2	543.2	114	500	253.5

FILTER TEST REPORT

TEST CONDITIONS Pyrite Concentrate

FILTER CLOTH SPECS. 5524 Neotex from Porritts & Spencer

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.		
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Total Cycle
82	-	-	61.5	3.7	22	23	21	38	38	76
83	-	-	60.7	3.7	22	20	20	48	48	96
84	-	-	61.5	3.7	22	20	20	55	55	110
85	-	-	61.8	3.7	22	20	20	51	153	204
86	-	-	62.4	3.7	22	30	28	30	150	180
87	-	-	61.3	3.7	22	25	25	30	90	120

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA		
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry $kg/h/m^2$	Volume mL	Clarity particulates ppm	Rate $L/h/m^2$
			Wet	Dry					
82	7 lg & med	10	289.6	244.6	15.5	944.6	108	500	417.1
83	1 lg,1 sml	10	292.5	244.2	16.5	746.6	110	500	336.3
84	2 lg,2 sml	12	348.9	294.5	15.6	785.8	130	500	346.9
85	1 small	12	346.4	297.0	14.3	427.3	134	500	192.8
86	4	12	340.2	297.3	12.6	484.8	136	500	221.8
87	5	10	284.0	245.2	13.7	599.7	116	500	283.7

FILTER TEST REPORT

TEST CONDITIONS

Pyrite Concentrate
FILTER CLOTH SPECS. PO 802 HF, EIMCO

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.		
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Total Cycle
88	-	-	62.3	3.7	22	30	29	48	48	96
89	-	-	62.0	3.7	22	30	25	87	87	174
90	-	-	62.3	3.7	22	30	28	78	234	312
91	-	-	62.4	3.7	22	30	28	78	156	234
92	-	-	60.9	3.7	22	29	28	50	50	100

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA		
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry $kg/h/m^2$	Volume mL	Clarity particulates ppm	Rate $L/h/m^2$
			Wet	Dry					
88	-	16	458.3	393.9	14.1	1204.2	174	2000	532.0
89	3	16	460.4	394.6	14.3	665.6	176	2000	296.9
90	2 sml,1med	16	457.2	394.2	13.8	370.8	176	2000	165.6
91	4	16	455.8	393.1	13.8	493.0	174	2000	218.2
92	3	12	341.3	293.0	14.2	859.9	134	2000	393.3

FILTER TEST REPORT

TEST CONDITIONS Pyrite Concentrate

FILTER CLOTH SPECS. NY 527F, EIMCO

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.		
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Total Cycle
93	-	-	60.9	3.7	22	20	19	61	61	122
94	-	-	61.9	3.7	22	30	29	68	68	136
95	-	-	61.9	3.7	22	30	26	70	140	210
96	-	-	61.1	3.7	22	30	24	82	82	164

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA		
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry kg/h/m^2	Volume mL	Clarity particulates ppm	Rate L/h/m^2
			Wet	Dry					
93	6	12	348.3	293.9	15.6	707.0	134	11,000	322.4
94	2 small	16	460.1	396.4	13.8	855.4	180	11,000	388.4
95	1 lg,2 sml	16	455.1	393.1	13.6	549.4	180	11,000	251.6
96	3 large	16	462.0	390.9	15.4	699.6	178	11,000	318.5

FILTER TEST REPORT

TEST CONDITIONS

Pyrite Concentrate
FILTER CLOTH SPECS. PO 802 HF, EIMCO

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.		
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Total Cycle
97	-	-	62.2	3.7	22	30	30	97	97	194
98	-	-	62.1	3.7	22	30	30	80	160	240
99	-	-	62.1	3.7	22	30	29	88	264	352
100	Percol 455	50	61.1	3.7	22	30	25	65	65	130
101	Percol 455	50	61.2	3.7	22	30	28	64	128	192
102	Percol 455	50	61.3	3.7	22	30	26	55	165	220
103	Percol 455	75	60.4	3.7	22	30-27	25	65	65	130
104	Percol 455	100	59.6	3.7	22	30-27	22	70	70	140
105	Percol 455	100	60.3	3.7	22	30-27	25	48	144	192

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA		
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry kg/h/m^2	Volume mL	Clarity particulates ppm	Rate L/h/m^2
			Wet	Dry					
97	none	16	456.0	394.5	13.5	596.8	178	2000	269.3
98	none	16	458.3	397.6	13.2	486.2	182	2000	222.6
99	none	16	456.4	396.2	13.2	330.3	182	2000	151.7
100	1 lg,1 sml	16	458.5	389.2	15.1	878.7	178	2000	401.9
101	1 sml,1 sd	16	454.1	393.1	13.4	600.9	188	2000	287.4
102	1 large	16	445.6	388.4	12.8	518.2	188	2000	250.8
103	3 sml,3 sd	16	456.1	385.1	15.6	869.4	182	2000	410.9
104	2 lg, 4 sd	16	456.1	379.0	16.1	794.5	180	2000	377.3
105	1 med,1 sd	16	444.4	385.0	13.4	588.5	194	2000	296.6

FILTER TEST REPORT

TEST CONDITIONS — Pyrite Concentrate

FILTER CLOTH SPECS. PO 802 HF, EIMCO

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.		
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Total Cycle
106	Percol 455	100	59.3	3.7	22	30-26	16	70	140	210
107	Percol 455	100	59.8	3.7	22	30-27	23	46	92	138
108	-	-	62.1	3.7	22	30-29	28	80	240	320
109	-	-	59.6	8.0	22	30-28	28	93	93	186

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA		
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry kg/h/m^2	Volume mL	Clarity particulates ppm	Rate L/h/m^2
			Wet	Dry					
106	4 large	16	464.3	377.5	18.7	527.6	172	2000	240.4
107	4 large	16	447.6	380.1	15.1	808.4	188	2000	399.8
108	4 large	16	457.0	394.3	13.7	361.6	178	2000	163.3
109	4 large	16	459.9	393.3	14.5	620.6	200	2000	315.6

APPENDIX C

FLOTATION TAILINGS
SETTLING TESTS 8-33

SETTLING TEST REPORT

Flotation Tails (without dust)

Test #8

Time Min	Mudline mL column	Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	20	455	240	320
1	980	21	430	300	320
2	950	22	413	330	320
3	925	23	403	1320	320
4	900	24	398		
5	870	25	391		
6	840	26	386		
7	815	27	380		
8	780	28	375		
9	760	29	370		
10	730	30	366		
11	700	35	349		
12	675	40	342		
13	650	50	336		
14	620	60	332		
15	590	75	329		
16	560	90	325		
17	535	105	323		
18	510	180	320		
19	485	210	320		

FLOCCULANT: None

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1856.1 g
CYL. EMPTY	623.3 g
SLURRY	1232.8 g

SLURRY DENSITY: 29.9 % solids

Solids: 368.1 g (Dry)

SETTLING TEST REPORT

Flotation Tails (without dust)

Test #9

Time Min	Mudline ml column	Time Min	Mudline ml column
0	1010	20	400
1	970	25	389
2	900	30	380
3	810	40	368
4	720	50	359
5	630	60	352
6	555	80	345
7	520	120	338
8	500	150	336
9	480	1140	332
10	465		
11	450		
12	440		
13	431		
14	424		
15	419		
16	412		
17	410		
18	405		
19	401		

FLOCCULANT: Separan XD 10 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1898.0 g
CYL. EMPTY	663.6 g
SLURRY	1234.4 g

SLURRY DENSITY: 29.8 % solids

Solids: 367.4 g (dry)

SETTLING TEST REPORT

Flotation Tails (without dust)

Test #10

Time Min	Mudline cm. column	Time Min	Mudline cm. column
0	1010	15	395
¼	920	16	391
½	820	17	389
¾	730	18	387
1	650	19	384
1¼	605	20	381
1½	570	25	372
1¾	540	30	368
2	515	40	360
2¼	495	50	355
2½	480	60	352
3	458	90	349
4	444	120	348
5	434	190	348
6	427	210	347
7	419		
8	412		
9	407		
10	402		
11	399		
12			
13			
14			

FLOCCULANT: Separan XD 20 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT	CYL. + SLURRY	1898.0 g
	CYL. EMPTY	663.6 g
	SLURRY	1234.4 g
SLURRY DENSITY:	29.8 % solids	

Solids: 367.4 g (dry)

SETTLING TEST REPORT

Flotation Tails (without dust)

Test #11

Time Min	Mudline ml column	Time Min	Mudline ml column
0	1020	16	393
¼	915	17	390
1	810	18	388
2	650	19	385
2¼	600	20	382
3	560	25	375
3¼	530	30	370
4	505	40	364
4¼	485	50	360
5	473	60	359
6	457	90	356
7	445	120	355
8	434	150	354
9	426		
10	419		
11	413		
12	408		
13	404		
14	400		
15	397		

FLOCCULANT: Separan XD 50 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1898.0 g
CYL. EMPTY	663.6 g
SLURRY	1234.4 g

Solids: 367.4 g (dry)

SLURRY DENSITY: 29.8 % solids

SETTLING TEST REPORT

Flotation Tails (without dust)

Test #12

Time Min	Mudline ml column	Time Min	Mudline ml column
0	1030	15	400
½	930	16	398
1	830	17	395
1½	735	18	392
2	670	19	389
2½	620	20	387
3	575	25	380
3½	540	30	375
4	520	45	367
4½	500	60	363
5	485	90	360
6	465	180	358
7	452	210	357
8	440	240	356
9	432	300	356
10	425	330	356
11	418	1290	352
12	413		
13	408		
14	404		

FLOCCULANT: Separan XD 100 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1898.0 g
CYL. EMPTY	663.6 g
SLURRY	1234.4 g

SLURRY DENSITY: 29.8 % solids

Solids: 367.4 g (dry)

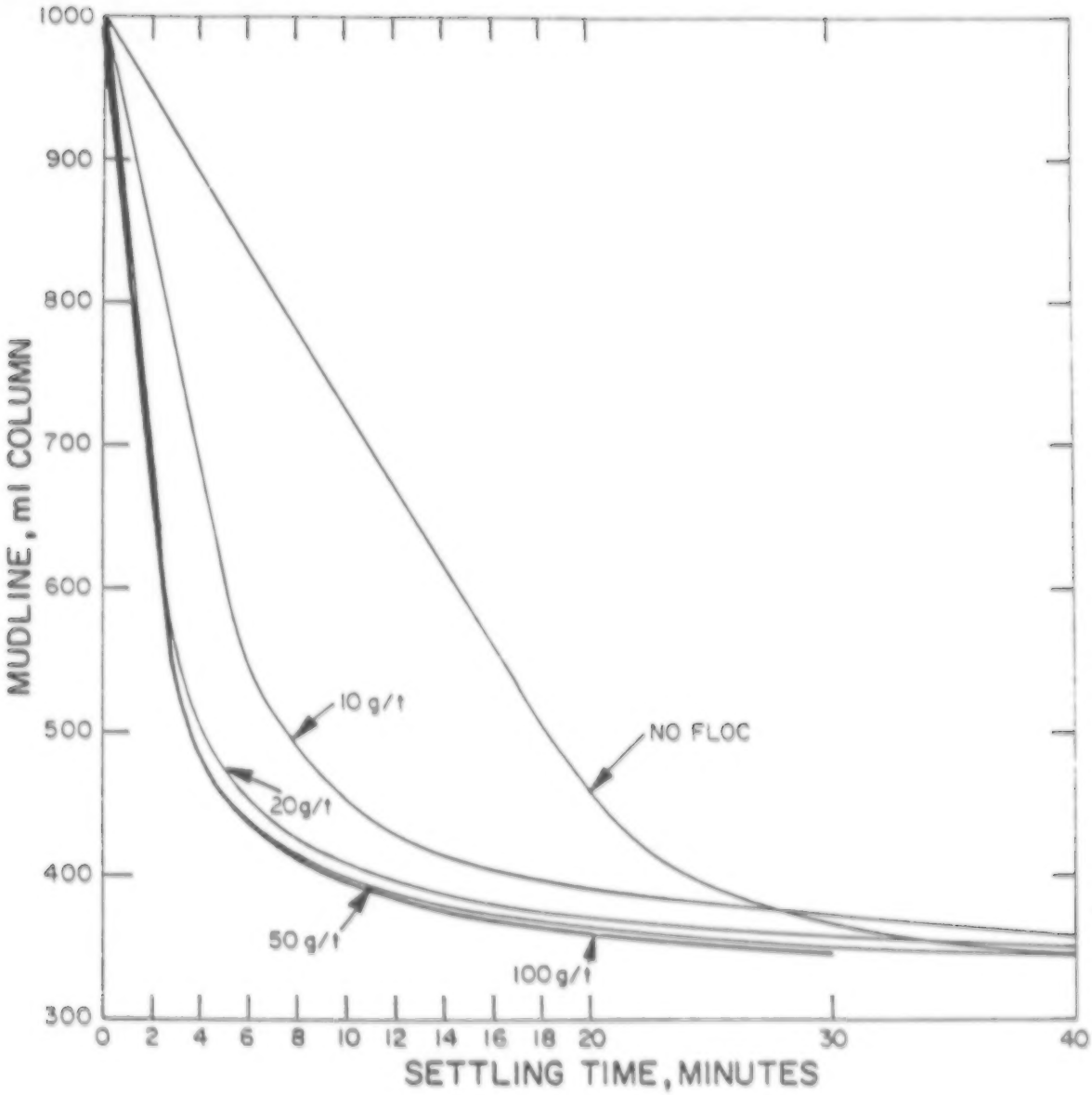

Figure 2 - Settling tests: Flotation tailing (without dust), Separan XD vs. no flocculant

SETTLING TEST REPORT

Flotation Tails (without dust)

Test #13

Time Min	Mudline ml. column	Time Min	Mudline ml. column
0	1000	20	375
1	930	25	366
2	750	30	359
3	530	45	348
4	480	60	342
5	460	90	338
6	447	120	337
7	435	150	335
8	426	180	335
9	419		
10	412		
11	407		
12	401		
13	398		
14	393		
15	390		
16	386		
17	383		
18	380		
19	378		

FLOCCULANT: Superfloc 127 10 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1864.1 g
CYL. EMPTY	634.4 g
SLURRY	1229.7 g

Solids: 368.1 g (dry)

SLURRY DENSITY: 29.9 % solids

SETTLING TEST REPORT

Flotation Tails (without dust)

Test #14

Time Min	Mudline ml column	Time Min	Mudline ml column
0	1000	15	380
½	880	16	378
1	770	17	375
1½	675	18	373
2	605	19	371
2½	550	20	370
3	510	25	366
3½	485	30	362
4	465	45	358
4½	453	60	355
5	445	90	352
6	430	120	351
7	420	150	350
8	410	180	350
9	403	210	350
10	398	240	350
11	392		
12	388		
13	385		
14	382		

FLOCCULANT: Superfloc 127 20 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1864.1 g
CYL. EMPTY	634.4 g
SLURRY	1229.7 g

SLURRY DENSITY: 29.9 % solids

Solids: 368.1 g (dry)

SETTLING TEST REPORT

Flotation Tails (without dust)

Test #15

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1010	15	385
½	890	16	383
1	780	17	382
1½	680	18	381
2	580	19	380
2½	510	20	380
3	480	25	378
3½	465	30	376
4	450	45	373
4½	440	60	370
5	430	120	368
6	420	150	368
7	410	1110	362
8	405		
9	400		
10	395		
11	392		
12	390		
13	388		
14	386		

FLOCCULANT: Superfloc 127 50 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT CYL. + SLURRY 1864.1 g

CYL. EMPTY 634.4 g

SLURRY 1229.7 g

Solids: 368.1 g (dry)

SLURRY DENSITY: 29.9 % solids

SETTLING TEST REPORT

Flotation Tails (without dust)

Test #16

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1030	15	388
¼	870	16	388
1	745	17	387
1¼	610	18	386
2	510	19	386
2¼	480	20	385
3	457	25	382
3¼	442	30	380
4	432	45	379
4¼	425	60	377
5	419	90	375
6	410	120	373
7	405	150	372
8	400	180	371
9	398	210	371
10	396	240	370
11	393	300	370
12	390	360	370
13	390	420	369
14	389	1440	366

FLOCCULANT: Superfloc 127 100 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1864.1 g
CYL. EMPTY	634.4 g
SLURRY	1229.7 g

Solids: 368.1 g (dry)

SLURRY DENSITY: 29.9 % solids

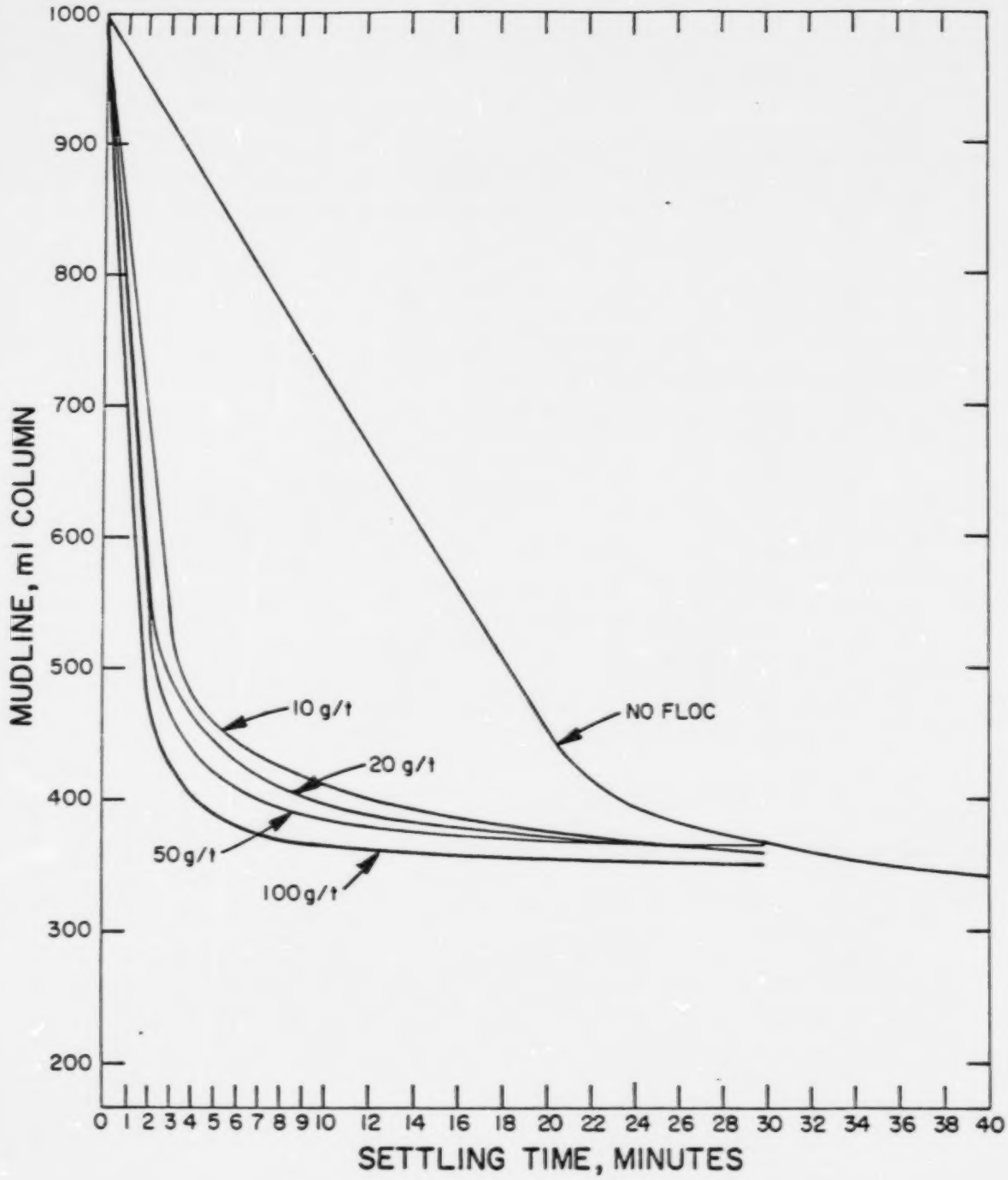

Figure C2 - Settling tests: Flotation tailing (without dust), Superfloc 127 vs no flocculant

SETTLING TEST REPORT

Flotation Tails (without dust)

Test #17

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1010	20	390
1	980	25	379
2	920	30	370
3	830	40	357
4	750	50	349
5	650	60	342
6	550	100	333
7	470	130	331
8	458	1140	329
9	448		
10	438		
11	430		
12	422		
13	418		
14	412		
15	408		
16	403		
17	400		
18	396		
19	393		

FLOCCULANT: Superfloc 16 — 10 g/t

TEMPERATURE: 20°C

Solids S.G.: 2.6

WEIGHT

CYL. + SLURRY	1911.4 g
CYL. EMPTY	676.4 g
SLURRY	1235.0 g

SLURRY DENSITY: 29.7 % solids

Solids: 366.8 g (dry)

SETTLING TEST REPORT

Flotation Tails (without dust)

Test #18

Time Min	Mudline ml column	Time Min	Mudline ml column
0	1010	16	388
½	920	17	385
1	805	18	382
1½	705	19	380
2	630	20	379
2½	580	30	365
3	540	40	360
3½	510	50	355
4	490	60	353
5	468	90	350
6	450	155	348
7	439	180	348
8	429		
9	420		
10	414		
11	408		
12	402		
13	399		
14	395		
15	390		

FLOCCULANT: Superfloc 16 — 20 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT — CYL. + SLURRY: 1911.4 g

CYL. EMPTY: 676.4 g

SLURRY: 1235.0 g

Solids: 366.8 g (dry)

SLURRY DENSITY: 29.7 % solids

SETTLING TEST REPORT

Flotation Tails (without dust)

Test #19

Time Min	Mudline ml column	Time Min	Mudline ml column
0	1010	16	393
½	915	17	390
1	820	18	389
1½	735	19	387
2	660	20	386
2½	590	25	380
3	548	30	378
3½	515	45	374
4	495	60	370
5	470	90	368
6	453	120	367
7	440		
8	430		
9	421		
10	415		
11	410		
12	405		
13	400		
14	398		
15	396		

FLOCCULANT: Superfloc 16 — 50 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1911.4 g
CYL. EMPTY	676.4 g
SLURRY	1235.0 g

Solids: 366.8 g (dry)

SLURRY DENSITY: 29.7 % solids

SETTLING TEST REPORT

Flotation Tails (without dust)

Test #20

Time Min	Mudline ml column	Time Min	Mudline ml column
0	1030	15	399
½	910	16	398
1	800	17	397
1½	690	18	396
2	580	19	395
2½	520	20	394
3	490	25	390
3½	475	30	389
4	460	45	386
4½	450	60	384
5	442	140	380
6	430	180	378
7	422	210	378
8	417	270	377
9	412	300	377
10	409	1260	372
11	406		
12	403		
13	401		
14	400		

FLOCCULANT: Superfloc 16 — 100 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT — CYL. + SLURRY: 1911.4 g

CYL. EMPTY: 676.4 g

SLURRY: 1235.0 g

Solids: 366.8 g (dry)

SLURRY DENSITY: 29.7 % solids

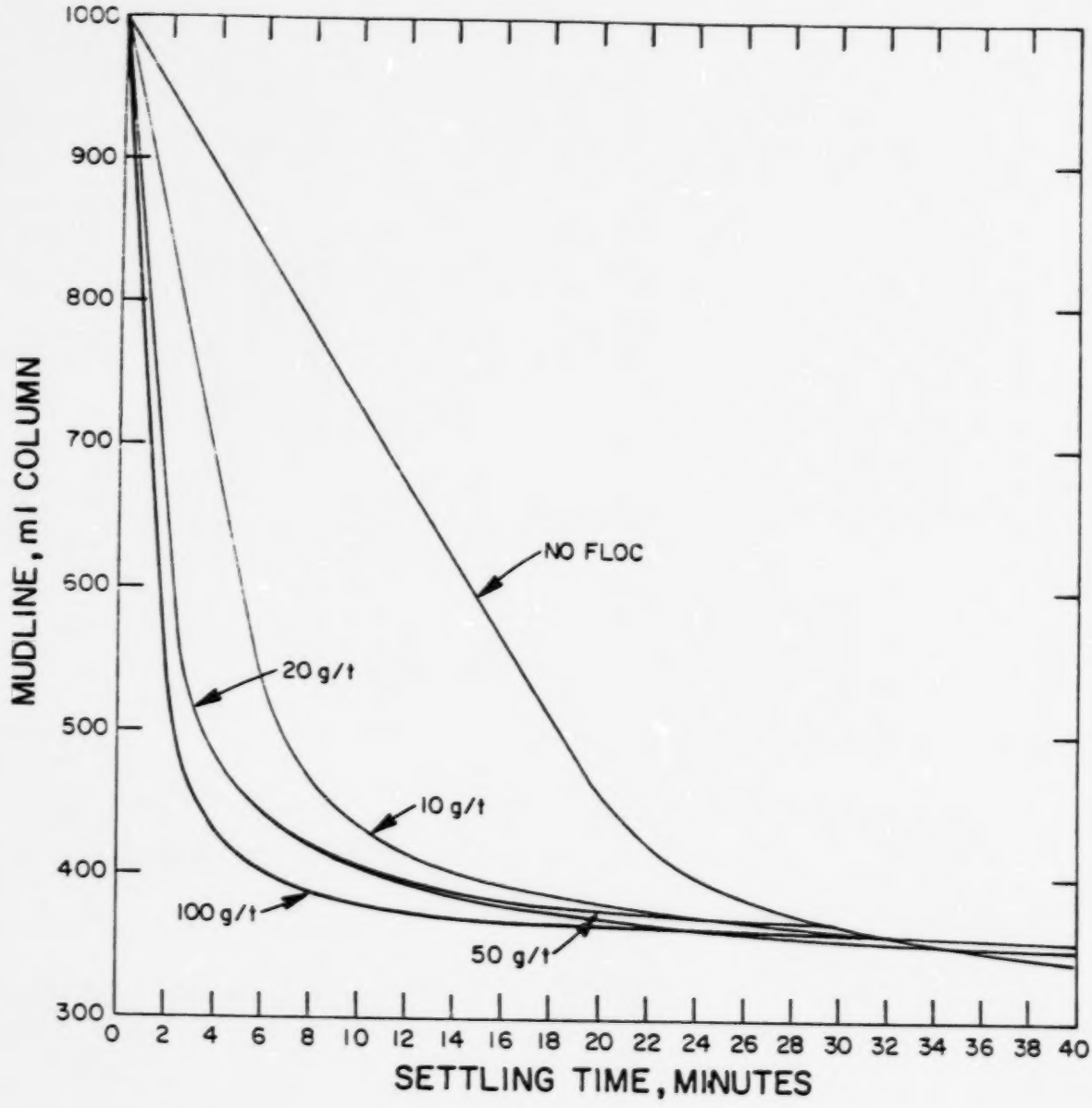

Figure 3 - Settling tests: Flotation tailing (without dust)
Superfloc 16 vs. no flocculant

SETTLING TEST REPORT

Flotation Tailing (99.7%) and Pyrite Roasting Dust (0.3%)

Test #21

Time Min	Mudline mL column	Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	20	610	40	380
1	990	21	590	45	360
2	970	22	570	50	350
3	950	23	550	55	345
4	930	24	530	60	341
5	910	25	510	90	331
6	890	26	490	120	328
7	870	27	470	150	325
8	850	28	460	1140	323
9	830	29	445		
10	810	30	435		
11	790	31	428		
12	770	32	420		
13	750	33	415		
14	730	34	409		
15	710	35	404		
16	690	36	400		
17	670	37	395		
18	650	38	390		
19	630	39	385		

FLOCCULANT: None

Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT	CYL. + SLURRY	1882.1 g
	CYL. EMPTY	665.3 g
	SLURRY	1216.8 g
SLURRY DENSITY:	29.6 % solids	

Solids: 359.8 g (Dry)

SETTLING TEST REPORT

Flotation Tailing (99.7%) and Pyrite Roasting Dust (0.3%)

Test #22

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	20	410
1	980	25	395
2	930	30	384
3	870	40	370
4	820	50	359
5	750	60	350
6	700	95	339
7	650	120	335
8	600	150	332
9	550	180	331
10	510		
11	495		
12	480		
13	470		
14	458		
15	448		
16	439		
17	430		
18	422		
19	416		

FLOCCULANT: Separan XD 10 g/t

Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT

CYL. + SLURRY	1838.7 g
CYL. EMPTY	616.2 g
SLURRY	1222.5 g

SLURRY DENSITY: 29.4 % solids

Solids: 359.5 g (dry)

SETTLING TEST REPORT

Flotation Tailing (99.7%) and Pyrite Roasting Dust (0.3%)

Test #23

Time Min	Mudline ml column	Time Min	Mudline ml column
0	1000	20	396
½	970	25	383
1	910	30	374
1½	830	40	361
2	760	50	354
2½	690	60	350
3	630	90	343
3½	595	120	341
4	570	150	340
4½	549		
5	530		
6	500		
7	480		
8	466		
9	453		
10	444		
12	430		
14	419		
16	409		
18	401		

FLOCCULANT: Separan XD 20 g/t

Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT

CYL. + SLURRY	1838.7 g
CYL. EMPTY	616.2 g
SLURRY	1222.5 g

Solids: 359.5 g (dry)

SLURRY DENSITY: 29.4 % solids

SETTLING TEST REPORT

Flotation Tailing (99.7%) and Pyrite Roasting Dust (0.3%)

Test #24

Time Min	Mudline ml column	Time Min	Mudline ml column
0	1005	15	404
½	935	16	400
1	840	20	390
1½	750	25	380
2	680	30	372
2½	630	40	363
3	598	50	359
3½	565	60	356
4	540	90	350
4½	518	120	349
5	500	150	348
6	474	180	348
7	459	210	347
8	448		
9	440		
10	431		
11	425		
12	419		
13	413		
14	409		

FLOCCULANT: Separan XD 50 g/t

Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT

CYL. + SLURRY	1838.7 g
CYL. EMPTY	616.2 g
SLURRY	1222.5 g

Solids: 359.5 g (dry)

SLURRY DENSITY: 29.4 % solids

SETTLING TEST REPORT

Flotation Tailing (99.7%) and Pyrite Roasting Dust (0.3%)

Test #25

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1025	15	409
½	930	20	393
1	845	30	377
1½	770	40	371
2	710	50	365
2½	660	60	362
3	620	105	358
3½	585	120	358
4	555	150	357
4½	532		
5	510		
6	487		
7	470		
8	458		
9	448		
10	439		
11	430		
12	423		
13	419		
14	413		

FLOCCULANT: Separan XD 100 g/t

Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT

CYL. + SLURRY	1838.7 g
CYL. EMPTY	616.2 g
SLURRY	1222.5 g

Solids: 359.5 g (dry)

SLURRY DENSITY: 29.4 % solids

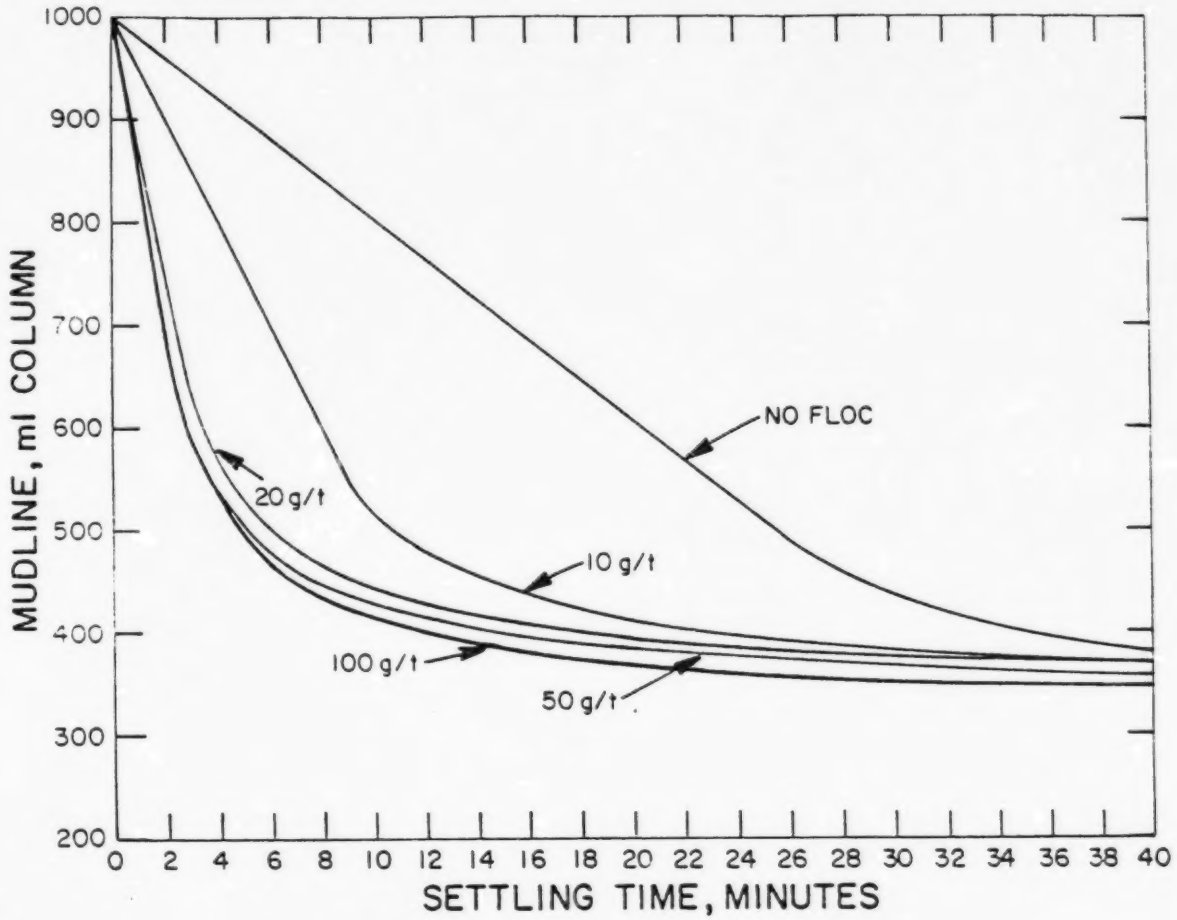

Figure C4 - Settling tests: Flotation tailing (99.7%) and dust (0.3%) Separan XD vs no flocculant

SETTLING TEST REPORT

Flotation Tailing (99.7%) and Pyrite Roasting Dust (0.3%)

Test #26

Time Min	Mudline ml column	Time Min	Mudline ml column
0	1000	20	383
1	960	25	378
2	920	30	358
3	880	40	345
4	840	50	337
5	800	60	332
6	760	75	329
7	720	110	325
8	680	120	324
9	640	150	323
10	600	180	322
11	560		
12	525		
13	490		
14	455		
15	425		
16	405		
17	395		
18	390		
19	387		

FLOCCULANT: S.F. 127 10 g/t

Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT CYL. + SLURRY 1891.3 g

CYL. EMPTY 669.1 g

SLURRY 1222.2 g

Solids: 358.4 g (dry)

SLURRY DENSITY: 29.3 % solids

SETTLING TEST REPORT

Flotation Tailing (99.7%) and Pyrite Roasting Dust (0.3%)

Test #27

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	20	368
½	890	25	362
1	800	30	359
1½	710	40	353
2	640	50	350
2½	580	60	349
3	530	75	348
3½	495	105	346
4	470	120	346
4½	460	150	345
5	450		
6	435		
7	421		
8	412		
9	405		
10	399		
12	389		
14	381		
16	375		
18	371		

FLOCCULANT: S.F. 127 — 20 g/t

Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT — CYL. + SLURRY: 1891.3 g

CYL. EMPTY: 669.1 g

SLURRY: 1222.2 g

Solids: 358.4 g (dry)

SLURRY DENSITY: 29.3 % solids

SETTLING TEST REPORT

Flotation Tailing (99.7%) and Pyrite Roasting Dust (0.3%)

Test #28

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1010	14	390
½	910	15	388
1	815	20	380
1½	730	30	370
2	650	40	368
2½	575	50	364
3	525	60	362
3½	500	95	360
4	482	120	359
4½	471	150	358
5	460	180	358
5½	450	210	358
6	442		
7	430		
8	420		
9	412		
10	403		
11	401		
12	398		
13	395		

FLOCCULANT: S.F. 127 — 50 g/t — Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT — CYL. + SLURRY: 1891.3 g

CYL. EMPTY: 669.1 g

SLURRY: 1222.2 g — Solids: 358.4 g (dry)

SLURRY DENSITY: 29.3 % solids

SETTLING TEST REPORT

Flotation Tailing (99.7%) and Pyrite Roasting Dust (0.3%)

Test #29

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1030	15	390
½	900	20	384
1	785	30	379
1½	670	40	377
2	560	50	375
2½	512	60	373
3	490	110	369
3½	470	120	369
4	454	150	368
4½	447		
5	439		
6	425		
7	417		
8	410		
9	405		
10	400		
11	398		
12	396		
13	393		
14	391		

FLOCCULANT: S.F. 127 — 100 g/t

Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT

CYL. + SLURRY	1891.3 g
CYL. EMPTY	669.1 g
SLURRY	1222.2 g

SLURRY DENSITY: 29.3 % solids

Solids: 358.4 g (dry)

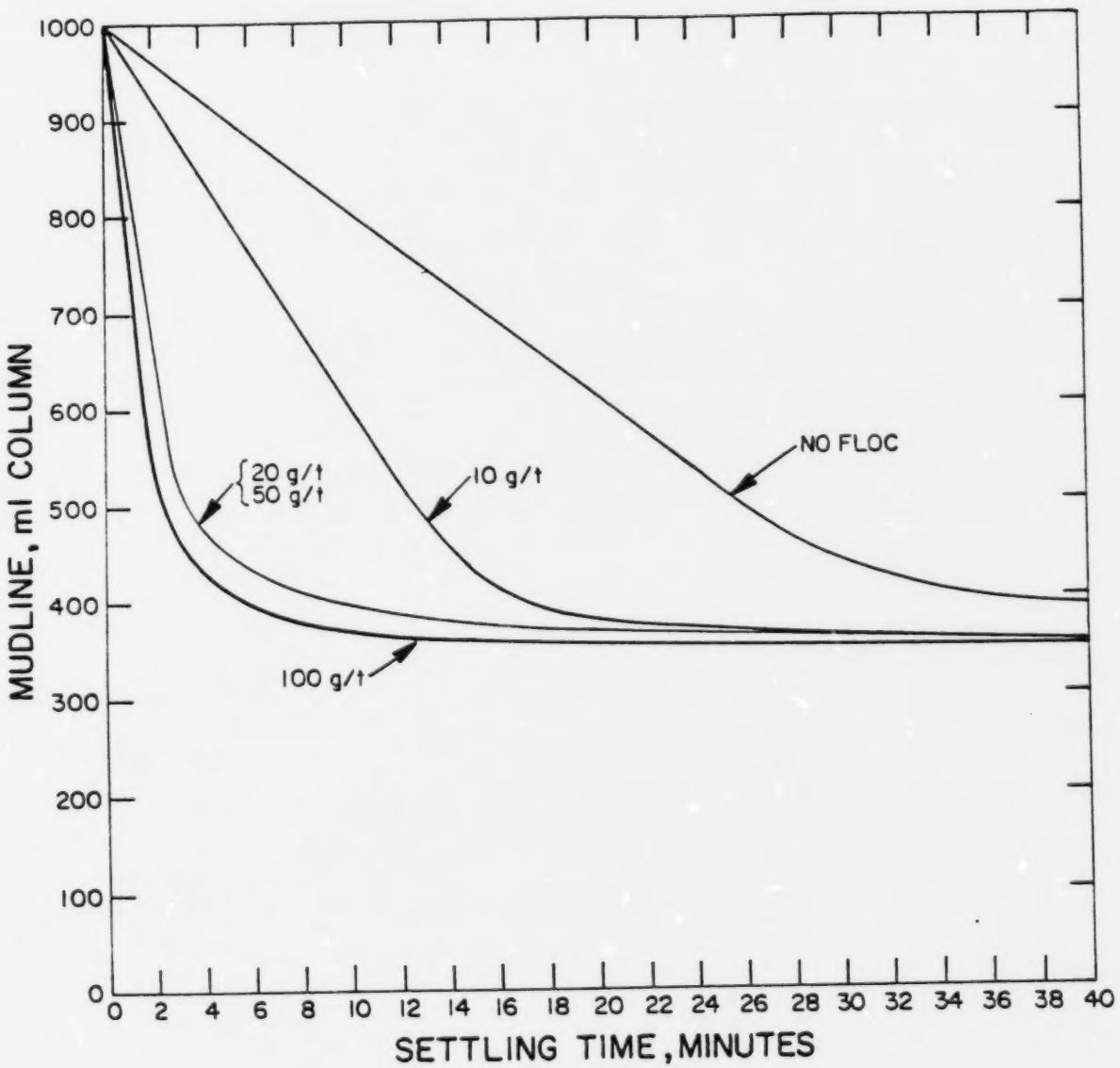

Figure C5 - Settling tests: Flotation tailing (99.7%) and dust (0.3%) Superfloc 127 vs no flocculant

SETTLING TEST REPORT

Flotation Tailing (99.7%) and Pyrite Roasting Dust (0.3%)

Test #30

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	20	387
1	980	25	371
2	950	30	361
3	920	40	350
4	890	50	342
5	860	60	339
6	830	75	334
7	790	90	332
8	750	120	330
9	710	150	330
10	680	225	329
11	640		
12	600		
13	560		
14	520		
15	480		
16	440		
17	400		
18	394		
19	390		

FLOCCULANT: Percol 455 — 10 g/t — Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT

CYL. + SLURRY	1850.6 g
CYL. EMPTY	634.7 g
SLURRY	1215.9 g

Solids: 360.5 g (dry)

SLURRY DENSITY: 29.6 % solids

SETTLING TEST REPORT

Flotation Tailing (99.7%) and Pyrite Roasting Dust (0.3%)

Test #31

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1005	15	378
½	875	20	370
1	770	25	365
1½	680	30	361
2	600	40	359
2½	545	50	357
3	505	60	355
3½	480	70	354
4	462	110	351
4½	450	120	351
5	441	165	350
6	428		
7	418		
8	408		
9	400		
10	395		
11	390		
12	387		
13	384		
14	380		

FLOCCULANT: Percol 455 20 g/t

Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT CYL. + SLURRY 1850.6 g

CYL. EMPTY 634.7 g

SLURRY 1215.9 g

Solids: 360.5 g (dry)

SLURRY DENSITY: 29.6 % solids

SETTLING TEST REPORT

Flotation Tailing (99.7%) and Pyrite Roasting Dust (0.3%)

Test #32

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1015	15	389
½	895	20	382
1	790	30	376
1½	690	40	373
2	600	50	371
2½	535	60	370
3	500	90	369
3½	480	120	368
4	467	150	367
4½	455	180	366
5	447	210	365
6	430		
7	420		
8	412		
9	408		
10	402		
11	399		
12	395		
13	392		
14	390		

FLOCCULANT: Percol 455 50 g/t

Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT CYL. + SLURRY 1850.6 g

CYL. EMPTY 634.7 g

SLURRY 1215.9 g

Solids: 360.5 g (dry)

SLURRY DENSITY: 29.6 % solids

SETTLING TEST REPORT

Flotation Tailing (99.7%) and Pyrite Roasting Dust (0.3%)

Test #33

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1030	50	381
½	850	60	380
1	695	100	379
1½	550	120	378
2	497	150	377
2½	470		
3	450		
3½	440		
4	430		
4½	425		
5	420		
6	412		
7	408		
8	404		
9	401		
10	400		
15	392		
20	390		
30	387		
40	383		

FLOCCULANT: Percol 455 100 g/t

Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT

CYL. + SLURRY	1850.6 g
CYL. EMPTY	634.7 g
SLURRY	1215.9 g

Solids: 360.5 g (dry)

SLURRY DENSITY: 29.6 % solids

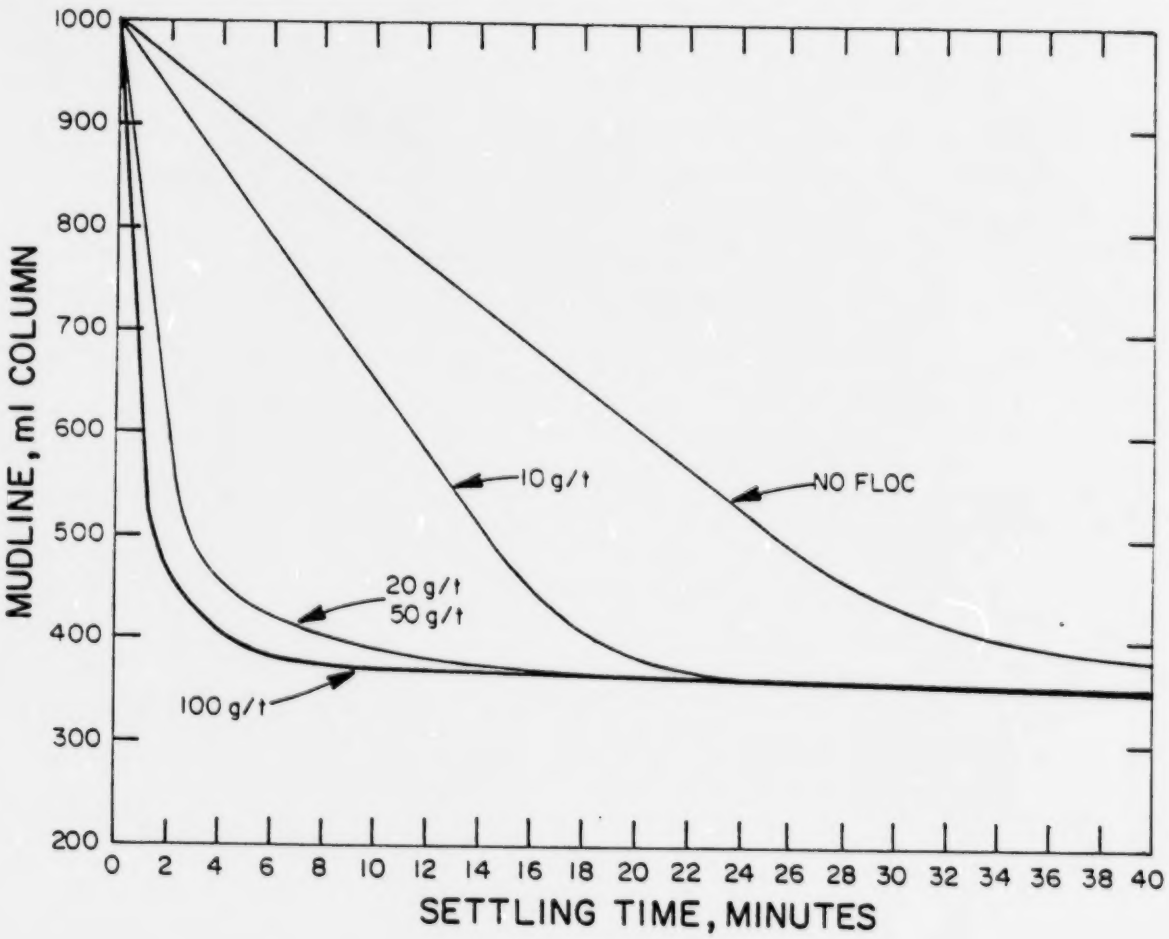

Figure 16 - Settling tests: Flotation tailing (99.7%) and dust (0.3%) Percol 455 vs no flocculant

APPENDIX D

FLOTATION TAILINGS
FILTER TESTS 1-16
50-54

FILTER TEST REPORT

TEST CONDITIONS Flotation Tailing with Dust Addition
FILTER CLOTH SPECS. 5524 Neotex from Porritts & Spencer

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.		
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Total Cycle
1	-	-	60.2	6.3	22	30	30	29	29	58
2	-	-	61.5	6.3	22	30	30	18	36	54
3	-	-	61.2	6.3	22	30	30	20	60	80
4	-	-	61.1	6.3	22	30	28	21	42	63
5	-	-	60.4	6.3	22	30	29	25	50	75
6	-	-	60.2	6.3	22	30	28	22	66	88
7	-	-	59.9	6.3	22	30	29	25	25	50
8	Percol 455	10	60.0	6.3	22	30	29	20	20	40
9	Percol 455	10	60.2	6.3	22	30	28	17	34	51

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA		
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry $kg/h/m^2$	Volume mL	Clarity particulates ppm	Rate $L/h/m^2$
			Wet	Dry					
1	None	18	407.3	349.8	14.1	1770.1	174	1000	880.5
2	None	18	407.8	356.4	12.6	1937.1	172	1000	934.8
3	None	18	404.0	356.0	11.9	1306.0	178	1000	653.0
4	None	18	412.4	354.8	14.0	1652.9	168	1000	782.7
5	None	18	406.3	354.0	12.9	1385.3	180	1000	704.4
6	None	18	401.8	352.8	12.2	1176.6	184	1000	613.7
7	None	18	409.5	353.1	13.8	2072.7	180	1000	1056.6
8	None	18	411.4	350.3	14.9	2570.3	172	600	1262.0
9	None	18	410.0	355.2	13.4	2044.1	180	600	1035.9

FILTER TEST REPORT

TEST CONDITIONS Flotation Tailing with Dust Addition
FILTER CLOTH SPECS. 5524 Neotex from Porritts & Spencer

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.		
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Total Cycle
10	Percol 455	10	59.9	6.3	22	30	28	27	81	108
11	Percol 455	20	60.2	6.3	22	30	28	16	48	64
12	Percol 455	20	59.8	6.3	22	30	28	18	18	36
13	Percol 455	20	59.8	6.3	22	29	29	22	44	66
14	Percol 455	20	60.8	6.3	22	29	27	13	39	52
15	Percol 455	20	60.6	6.3	22	29	27	13	26	39
16	Percol 455	20	59.9	6.3	22	29	27	15	15	30
13/15	Percol 455	20	59.5	6.3	22	29	28	18	36	54

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA		
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry $kg/h/m^2$	Volume mL	Clarity particulates ppm	Rate $L/h/m^2$
			Wet	Dry					
10	None	18	401.5	351.2	12.5	954.4	184	600	500.0
11	None	18	404.5	353.1	12.7	1619.3	182	600	834.6
12	None	18	415.1	351.1	15.4	2862.4	172	600	1402.2
13	None	18	404.3	349.2	13.6	1552.9	180	600	800.4
14	None	18	407.1	353.5	13.2	1995.2	174	600	982.1
15	None	18	410.1	354.1	13.6	2664.8	174	600	1309.4
16	None	18	416.6	351.4	15.7	3437.8	170	600	1663.1
13/15	None	18	407.2	351.7	13.6	1911.5	177	600	962.0

FILTER TEST REPORT

TEST CONDITIONS Flotation Tailing with Dust Addition
FILTER CLOTH SPECS. 5524 Neotex from Porritts & Spencer

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.		
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Total Cycle
50	Percol 455	10	60.1	6.3	22	30	30	18	36	54
51	Percol 455	10	58.6	6.3	22	30	30	20	40	60
52	Percol 455	10	59.2	6.3	22	30	30	20	60	80
53	Percol 455	20	60.4	6.3	22	30	30	13	39	52
54	Percol 455	20	59.9	6.3	22	30	30	13	39	52

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA		
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry $kg/h/m^2$	Volume mL	Clarity particulates ppm	Rate $L/h/m^2$
			Wet	Dry					
50	None	18	399.6	347.1	13.1	1886.5	178	600	967.4
51	None	18	400.3	346.0	15.7	1692.5	190	600	929.4
52	None	18	393.6	344.1	12.6	1262.4	188	600	689.7
53	None	18	400.5	348.3	13.0	1965.8	176	600	993.4
54	None	18	394.0	343.6	12.8	1939.3	180	600	1015.9

APPENDIX E

FINE FRACTION OF THE FLOTATION TAILING
SETTLING TESTS 34-39

SETTLING TEST REPORT

Flotation Tailing, Fine Fraction (-150 mesh)

Test #34

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	55	250
1	1000	60	247
2	1000	65	242
3	1000	70	240
4	1000	75	238
5	999	115	226
6	998	120	224
7	997	150	220
8	996	180	216
9	995		
10	994		
11	992		
12	990		
20	980		
25	970		
30	960		
35			
40			
45			
50			

FLOCCULANT: None

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1768.0 g
CYL. EMPTY	665.3 g
SLURRY	1102.7 g

SLURRY DENSITY: 15.3 % solids

Solids: 169.0 g (dry)

SETTLING TEST REPORT

Flotation Tailing, Fine Fraction (-150 mesh)

Test #35

Time Min	Mudline mL column
0	1000
1	1000
10	990
15	980
20	970
25	960
30	
35	
40	290
45	270
50	265
55	260
60	258
100	238
105	235
120	231
150	223
180	212

FLOCCULANT: Superfloc 127 — 20 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT — CYL. + SLURRY: 1772.4 g

CYL. EMPTY: 669.1 g

SLURRY: 1103.3 g

Solids: 170.5 g (dry)

SLURRY DENSITY: 15.5 % solids

SETTLING TEST REPORT

Flotation Tailing, Fine Fraction (-150 mesh)

Test #36

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1010	15	335
½	950	16	327
1	890	17	320
1½	825	18	313
2	770	19	309
2½	710	20	305
3	660	25	287
3½	615	30	270
4	590	40	258
4½	565	50	245
5	550	60	240
6	512	90	226
7	480	120	220
8	455	150	215
9	430	180	213
10	408		
11	390		
12	370		
13	358		
14	344		

FLOCCULANT: Superfloc 127 — 50 g/t

TEMPERATURE: 20°C

Solids S.G.: 2.6

WEIGHT

CYL. + SLURRY	1772.4 g
CYL. EMPTY	669.1 g
SLURRY	1103.3 g

SLURRY DENSITY: 15.5 % solids

Solids: 170.5 g (dry)

SETTLING TEST REPORT

Flotation Tailing, Fine Fraction (-150 mesh)

Test #37

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1015	15	260
½	750	20	248
1	525	25	240
1½	440	30	233
2	405	40	225
2½	380	50	218
3	365	60	215
3½	350	90	210
4	338	120	209
4½	330	180	208
5	322		
6	310		
7	300		
8	293		
9	287		
10	280		
11	275		
12	270		
13	267		
14	263		

FLOCCULANT: Superfloc 127 100 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT CYL. + SLURRY 1772.4 g

CYL. EMPTY 669.1 g

SLURRY 1103.3 g

SLURRY DENSITY: 15.5 % solids

Solids: 170.5 g (dry)

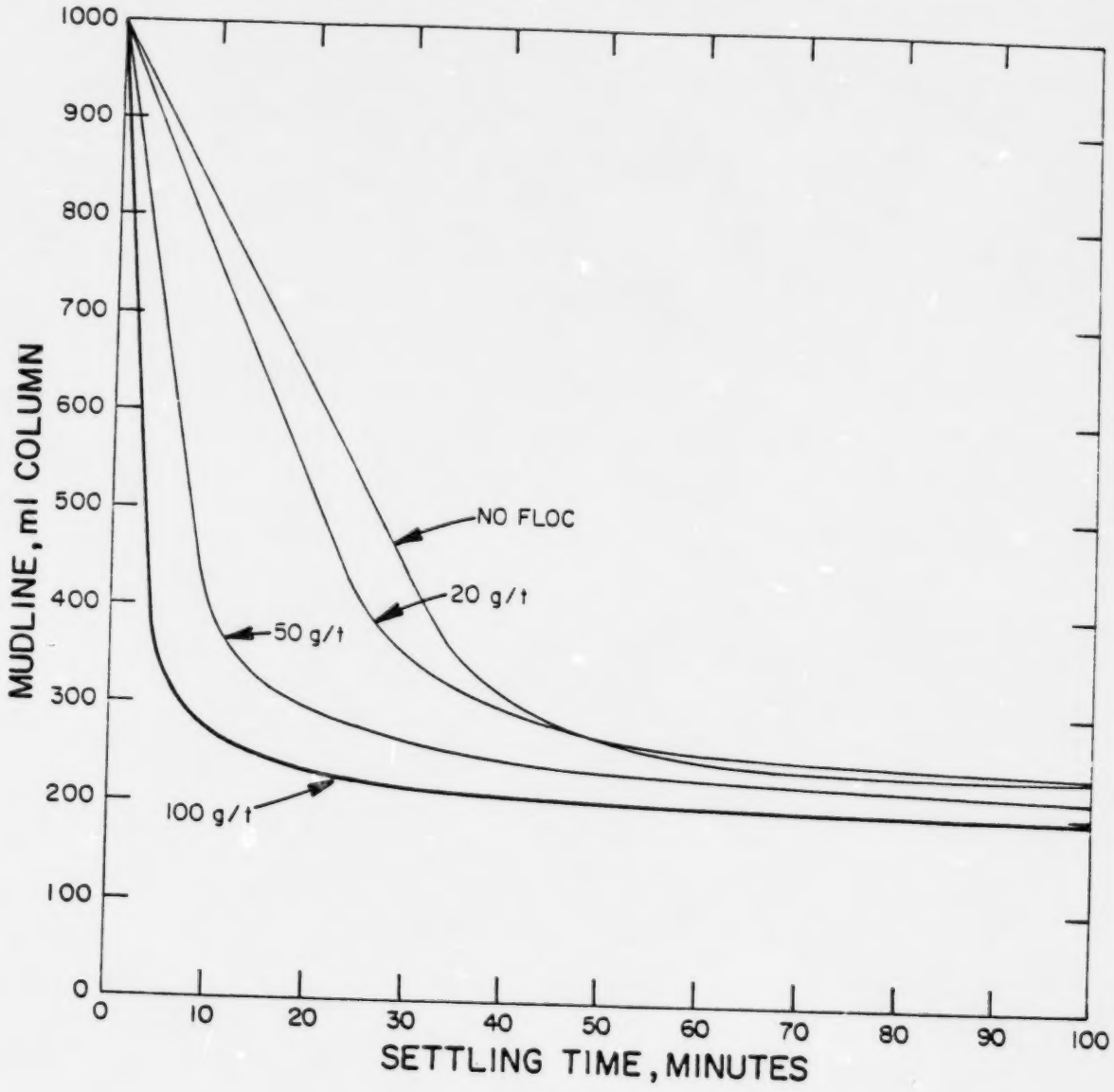

Figure E: - Settling tests: Fine fraction of flotation tailing, Superfloc 127 vs no flocculant

SETTLING TEST REPORT

Flotation Tailing, Fine Fraction (-150 mesh)

Test #38

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1005	15	285
½	920	20	261
1	840	25	250
1½	760	30	240
2	695	40	228
2½	630	50	220
3	580	60	218
3½	548	90	210
4	515	120	208
4½	490	150	206
5	462	180	205
6	420		
7	388		
8	360		
9	340		
10	325		
11	315		
12	305		
13	298		
14	291		

FLOCCULANT: Percol 455 50 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1724.8 g
CYL. EMPTY	616.2 g
SLURRY	1108.6 g

Solids: 170.1 g (dry)

SLURRY DENSITY: 15.3 % solids

SETTLING TEST REPORT

Flotation Tailing, Fine Fraction (-150 mesh)

Test #39

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1005	25	235
¼	450	30	232
½	390	40	230
¾	365	50	228
1	347	60	227
1½	323	90	226
2	310	120	225
2½	300	150	224
3	291	180	223
3½	285		
4	280		
4½	276		
5	272		
6	267		
7	261		
8	258		
9	255		
10	251		
15	245		
20	240		

FLOCCULANT: Percol 455 100 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1724.8 g
CYL. EMPTY	616.2 g
SLURRY	1108.6 g

Solids: 170.1 g (dry)

SLURRY DENSITY: 15.3 % solids

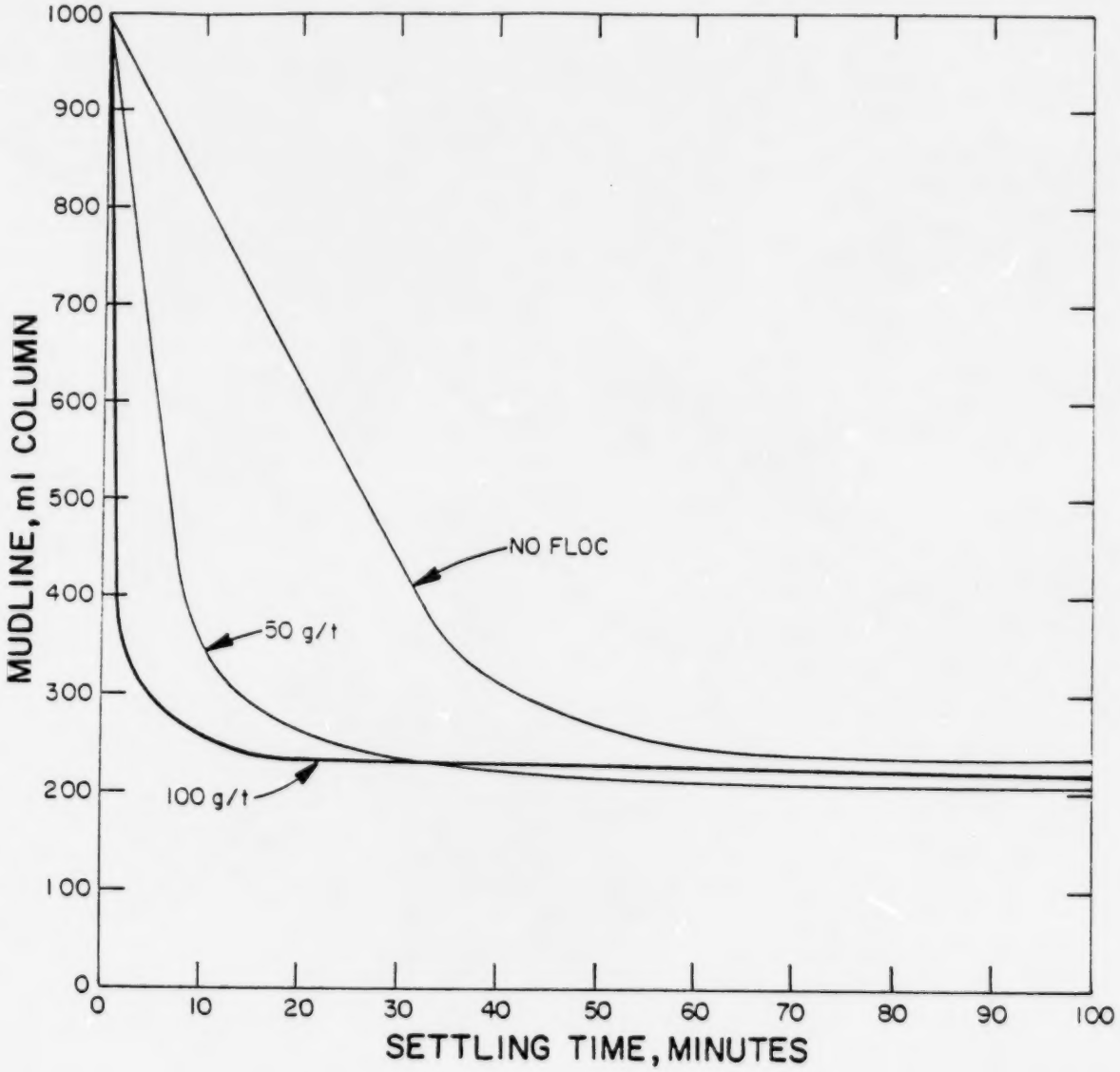

Figure 32 - Settling tests: Fine fraction of the flotation tailing Percol 455 vs no flocculant

APPENDIX F

PRECONCENTRATE
SETTLING TESTS 40-59

SETTLING TEST REPORT

Preconcentrate (without dust)

Test #40

Time Min	Mudline mL column	Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	20	610	40	150
1	1000	21	590	45	147
2	990	22	570	60	145
3	980	23	555	75	143
4	950	24	520	90	142
5	920	25	475	120	142
6	890	26	450	150	142
7	870	27	435	240	141
8	850	28	420		
9	830	29	400		
10	810	30	380		
11	790	31	360		
12	770	32	340		
13	750	33	315		
14	730	34	290		
15	710	35	260		
16	690	36	230		
17	670	37	210		
18	650	38	190		
19	630	39	170		

FLOCCULANT: None

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT
CYL. + SLURRY 1764.4 g
CYL. EMPTY 664.9 g
SLURRY 1099.5 g

Solids: 155.1 g (Dry)

SLURRY DENSITY: 14.1 % solids

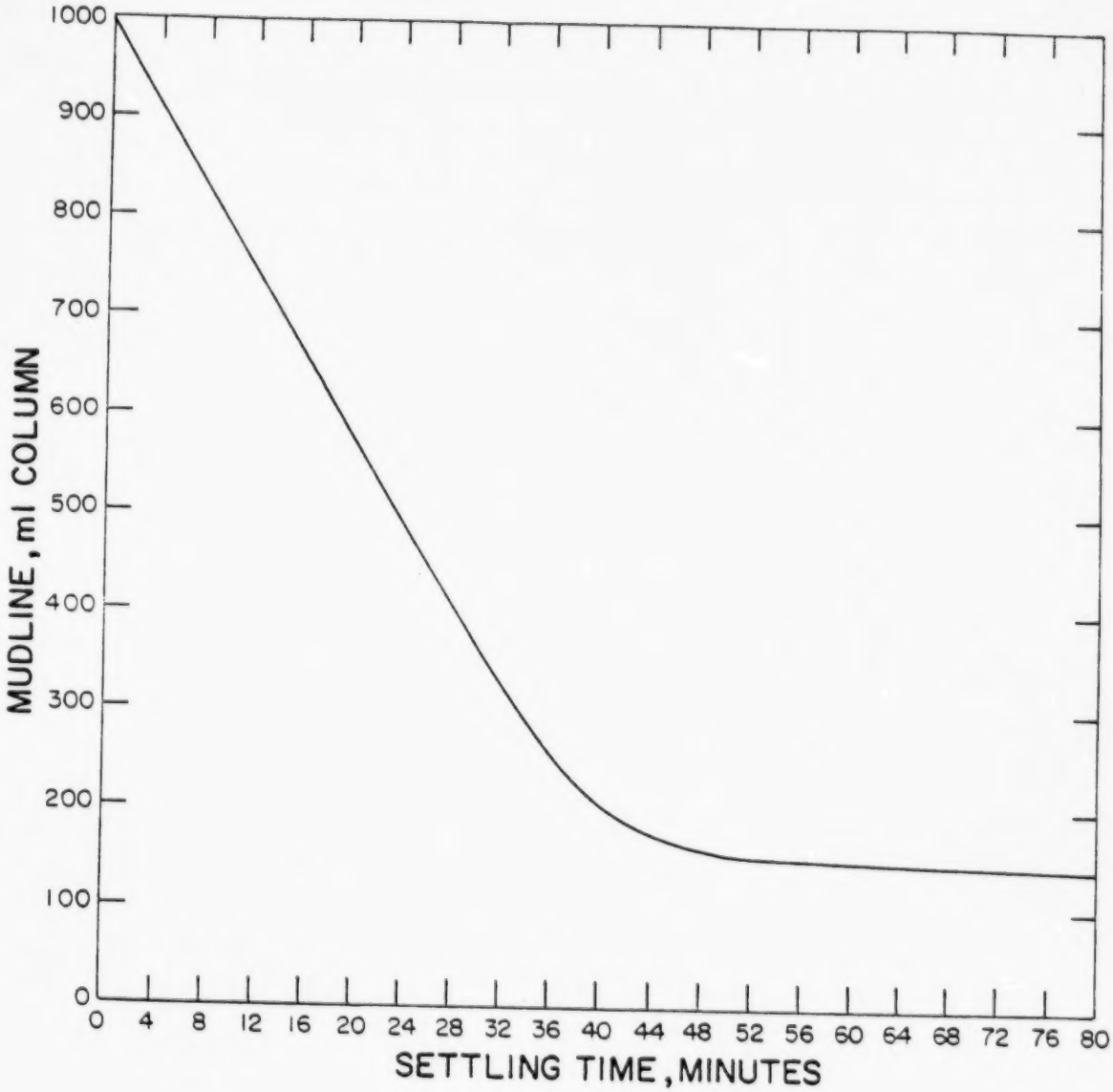

Figure F1 - Settling tests: Preconcentrate (without dust), no flocculant addition

SETTLING TEST REPORT

Preconcentrate (without dust)

Test #41

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	15	172
½	720	20	170
1	500	25	169
1½	320	30	168
2	275	40	167
2½	250	60	167
3	238	95	166
3½	228	120	166
4	218	180	165
4½	210		
5	204		
6	196		
7	190		
8	185		
9	181		
10	180		
11	178		
12	176		
13	175		
14	173		

FLOCCULANT: Separan MG 500 — 20 g/t

TEMPERATURE: 18°C — Solids S.G.: 2.6

WEIGHT

CYL. + SLURRY	1729.6 g
CYL. EMPTY	634.3 g
SLURRY	1095.3 g

SLURRY DENSITY: 14.1 % solids — Solids: 154.7 g (dry)

SETTLING TEST REPORT

Preconcentrate (without dust)

Test #42

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	30	178
¼	820	40	177
½	670	60	176
¾	510	90	175
1	375	120	174
1½	295	150	174
2	262		
2½	245		
3	230		
3½	220		
4	213		
4½	209		
5	203		
6	197		
7	191		
8	189		
9	187		
10	185		
15	180		
20	179		

FLOCCULANT: Separan MG 500 50 g/t

Solids S.G.: 2.6

TEMPERATURE: 18°C

WEIGHT

CYL. + SLURRY	1729.6 g
CYL. EMPTY	634.3 g
SLURRY	1095.3 g

SLURRY DENSITY: 14.1 % solids

Solids: 154.7 g (dry)

SETTLING TEST REPORT

Preconcentrate (without dust)

Test #43

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1010	40	180
¼	840	60	179
½	670	90	179
¾	500	120	178
1	370	150	178
1½	295	180	178
2	260	210	178
2½	240	270	178
3	230		
3½	220		
4	212		
5	202		
6	198		
7	193		
8	190		
9	189		
10	188		
15	184		
20	181		
30	180		

FLOCCULANT: Separan MG 500 100 g/t

Solids S.G.: 2.6

TEMPERATURE: 18°C

WEIGHT

CYL. + SLURRY	1729.6 g
CYL. EMPTY	634.3 g
SLURRY	1095.3 g

SLURRY DENSITY: 14.1 % solids

Solids: 154.7 g (dry)

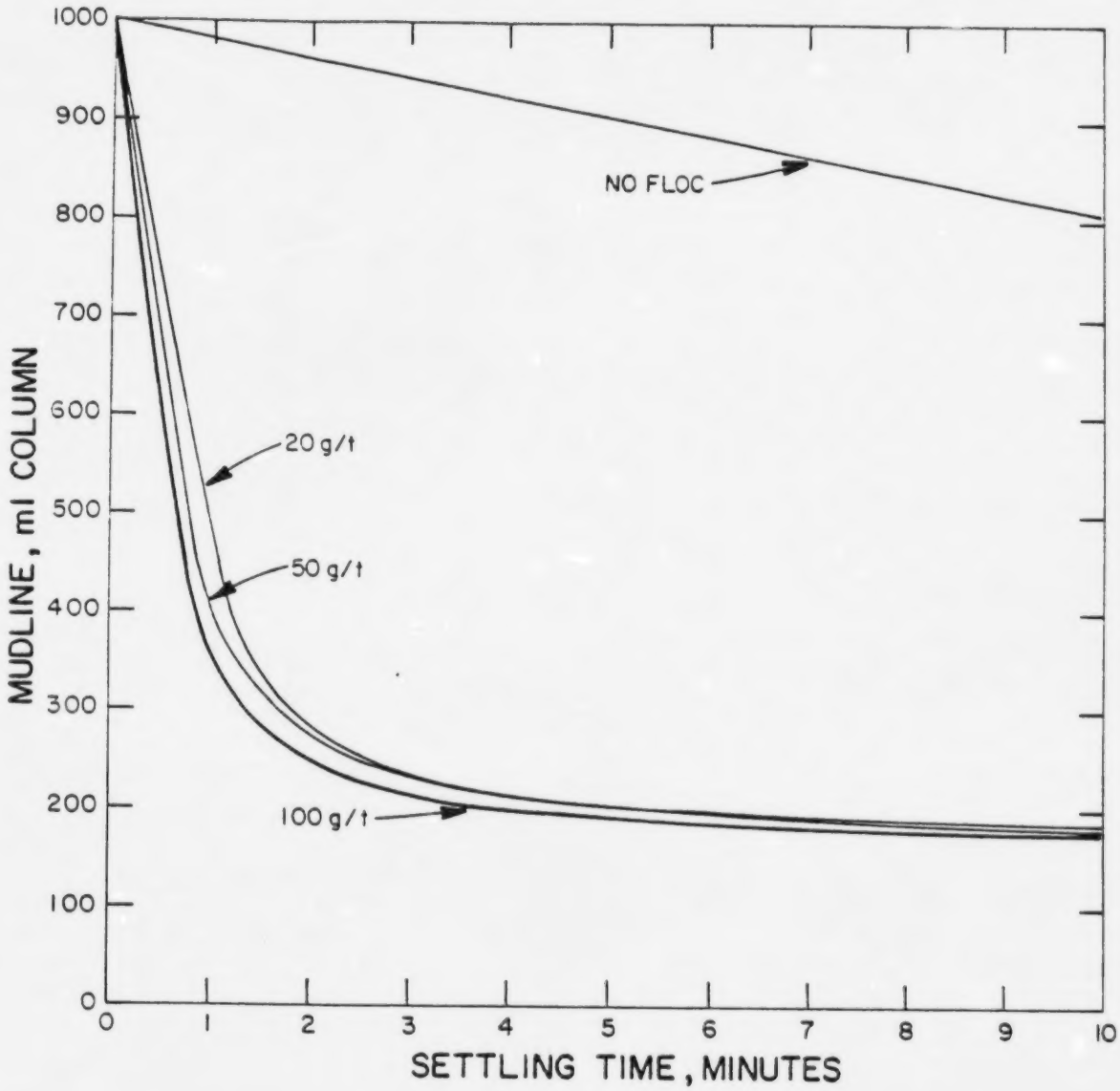

Figure F2 - Settling tests: Preconcentrate (without dust), Separan MG 500 vs no flocculant

SETTLING TEST REPORT

Preconcentrate (without dust)

Test #44

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	40	152
½	800	50	151
1	600	60	151
1½	400	90	151
2	250	120	150
2½	232	150	150
3	220	180	150
3½	210		
4	203		
4½	199		
5	194		
6	187		
7	180		
8	176		
9	171		
10	170		
15	161		
20	158		
25	156		
30	154		

FLOCCULANT: Superfloc 127 20 g/t

Solids S.G.: 2.6

TEMPERATURE: 18°C

WEIGHT CYL. + SLURRY 1730.4 g

CYL. EMPTY 634.8 g

SLURRY 1095.6 g

Solids: 154.8 g (dry)

SLURRY DENSITY: 14.1 % solids

SETTLING TEST REPORT

Preconcentrate (without dust)

Test #45

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	40	170
½	510	60	170
¾	330	90	169
1	285	120	168
1½	240	150	167
2	220	180	167
2½	208		
3	200		
3½	195		
4	190		
5	187		
6	183		
7	180		
8	179		
9	178		
10	178		
15	174		
20	172		
25	171		
30	170		

FLOCCULANT: Superfloc 127 50 g/t

Solids S.G.: 2.6

TEMPERATURE: 18°C

WEIGHT	CYL. + SLURRY	1712.7 g
	CYL. EMPTY	615.7 g
	SLURRY	1097.0 g
SLURRY DENSITY:	14.1 % solids	

Solids: 154.1 g (dry)

SETTLING TEST REPORT

Preconcentrate (without dust)

Test #46

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1010	60	175
15 sec	700	90	173
30 sec	420	120	172
45 sec	320	150	172
1	280	180	172
1½	240	210	171
2	220	240	171
2½	210	300	170
3	201		
4	195		
5	190		
6	188		
7	186		
8	185		
9	183		
10	182		
15	180		
20	180		
30	178		
40	177		

FLOCCULANT: Superfloc 127 — 100 g/t

Solids S.G.: 2.6

TEMPERATURE: 18°C

WEIGHT — CYL. + SLURRY: 1712.7 g

CYL. EMPTY: 615.7 g

SLURRY: 1097.0 g

SLURRY DENSITY: 14.1 % solids

Solids: 154.1 g (dry)

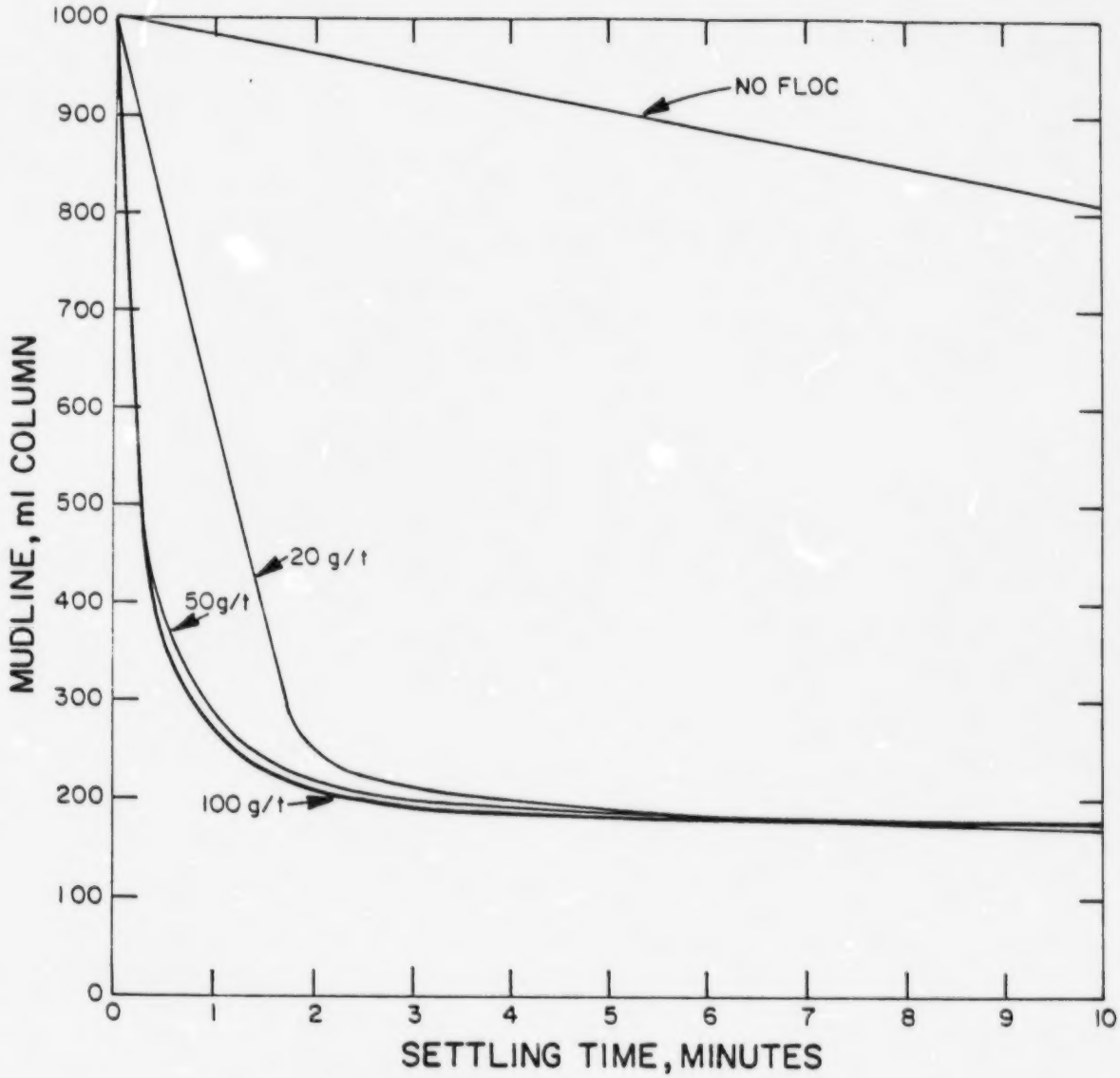

Figure F3- Settling tests: Preconcentrate (without dust), Superfloc 127 vs no flocculant

SETTLING TEST REPORT

Preconcentrate (without dust)

Test #47

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	15	164
½	670	20	162
1	400	25	161
1½	260	30	160
2	235	40	160
2½	218	50	160
3	207	60	160
3½	199	90	160
4	192	120	159
4½	188	180	159
5	184		
6	179		
7	175		
8	172		
9	170		
10	169		
11	168		
12	167		
13	166		
14	165		

FLOCCULANT: Superfloc 16 — 20 g/t

Solids S.G.: 2.6

TEMPERATURE: 18°C

WEIGHT — CYL. + SLURRY: 1769.9 g

CYL. EMPTY: 668.6 g

SLURRY: 1101.3 g

SLURRY DENSITY: 14.1 % solids

Solids: 154.7 g (dry)

SETTLING TEST REPORT

Preconcentrate (without dust)

Test #48

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	45	170
½	610	60	169
1	315	90	169
1½	255	120	168
2	230	180	168
2½	213	200	167
3	203		
3½	197		
4	193		
4½	190		
5	187		
6	182		
7	180		
8	179		
9	178		
10	177		
15	174		
20	172		
25	171		
30	171		

FLOCCULANT: Superfloc 16 50 g/t

Solids S.G.: 2.6

TEMPERATURE: 18°C

WEIGHT

CYL. + SLURRY	1769.9 g
CYL. EMPTY	668.6 g
SLURRY	1101.3 g

Solids: 154.7 g (dry)

SLURRY DENSITY: 14.1 % solids

SETTLING TEST REPORT

Preconcentrate (without dust)

Test #49

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1010	60	174
½	380	90	172
1	255	120	171
1½	220	150	171
2	206		
2½	200		
3	194		
3½	190		
4	188		
5	185		
6	183		
7	181		
8	181		
9	180		
10	180		
15	179		
20	178		
25	177		
30	176		
45	175		

FLOCCULANT: Superfloc 16 — 100 g/t

Solids S.G.: 2.6

TEMPERATURE: 18°C

WEIGHT

CYL. + SLURRY	1769.9 g
CYL. EMPTY	668.6 g
SLURRY	1101.3 g

SLURRY DENSITY: 14.1 % solids

Solids: 154.7 g (dry)

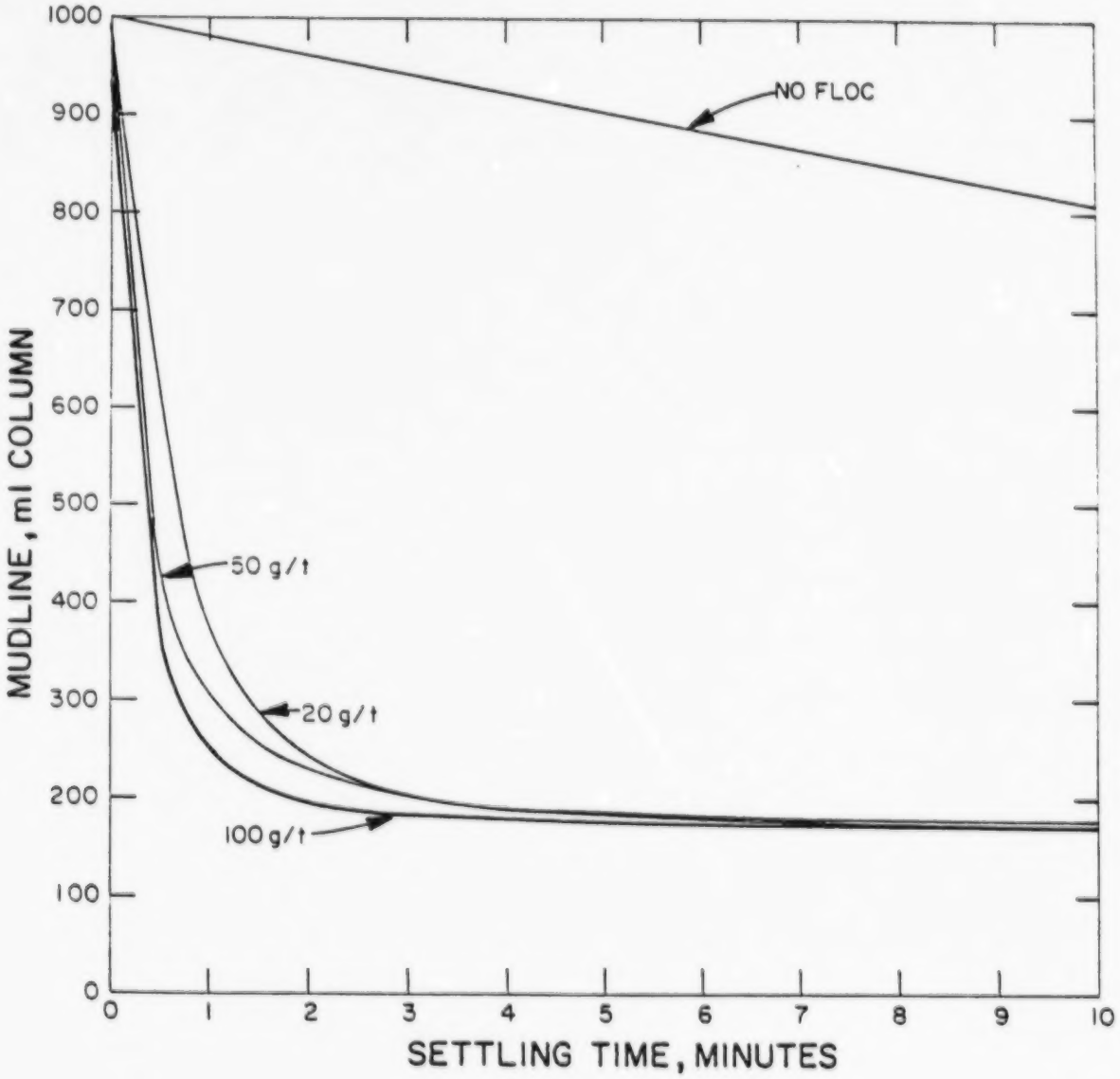

Figure F4 - Settling tests: Preconcentrate (without dust), Superfloc 16 vs no flocculant

SETTLING TEST REPORT

Preconcentrate (98.5%) and Pyrite Roasting Dust (1.5%)

Test #50

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	20	166
1	950	25	157
2	920	30	152
3	890	40	148
4	850	50	145
5	800	60	144
6	750	100	142
7	700	120	142
8	650	150	142
9	600		
10	550		
11	500		
12	450		
13	400		
14	350		
15	300		
16	250		
17	200		
18	175		
19	170		

FLOCCULANT: None

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT	CYL. + SLURRY	1755.2 g
	CYL. EMPTY	665.0 g
	SLURRY	1090.2 g
SLURRY DENSITY:	13.5 % solids	

Solids: 147.4 g (Dry)

SETTLING TEST REPORT

Preconcentrate (98.5%) and Pyrite Roasting Dust (1.5%)

Test #51

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	90	144
1	960	120	143
2	880	150	143
3	800	180	142
4	700		
5	550		
6	400		
7	300		
8	200		
9	193		
10	188		
11	184		
12	180		
13	177		
14	173		
15	170		
20	160		
30	150		
45	147		
60	145		

FLOCCULANT: Separan XD 20 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT CYL. + SLURRY 1707.0 g

CYL. EMPTY 616.2 g

SLURRY 1090.8 g

Solids: 146.8 g (Dry)

SLURRY DENSITY: 13.5 % solids

SETTLING TEST REPORT

Preconcentrate (98.5%) and Pyrite Roasting (1.5%)

Test #52

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	60	150
¼	900	90	150
1	680	120	150
1½	480	150	150
2	300		
2½	260		
3	240		
3½	230		
4	220		
4½	212		
5	207		
6	198		
7	190		
8	183		
9	180		
10	177		
15	164		
20	160		
30	153		
45	151		

FLOCCULANT: Separan XD 50 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT

CYL. + SLURRY	1707.0 g
CYL. EMPTY	616.2 g
SLURRY	1090.8 g

Solids: 146.8 g (dry)

SLURRY DENSITY: 13.5 % solids

SETTLING TEST REPORT

Preconcentrate (98.5%) and Pyrite Roasting (1.5%)

Test #53

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	90	149
1	600	120	148
1½	280	150	148
2	250	180	148
2½	230	210	148
3	220		
3½	211		
4	204		
4½	200		
5	195		
6	187		
7	180		
8	176		
9	171		
10	169		
15	159		
20	155		
30	151		
45	150		
60	149		

FLOCCULANT: Separan XD 100 g/t

Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT

CYL. + SLURRY	1707.0 g
CYL. EMPTY	616.2 g
SLURRY	1090.8 g

Solids: 146.8 g (dry)

SLURRY DENSITY: 13.5 % solids

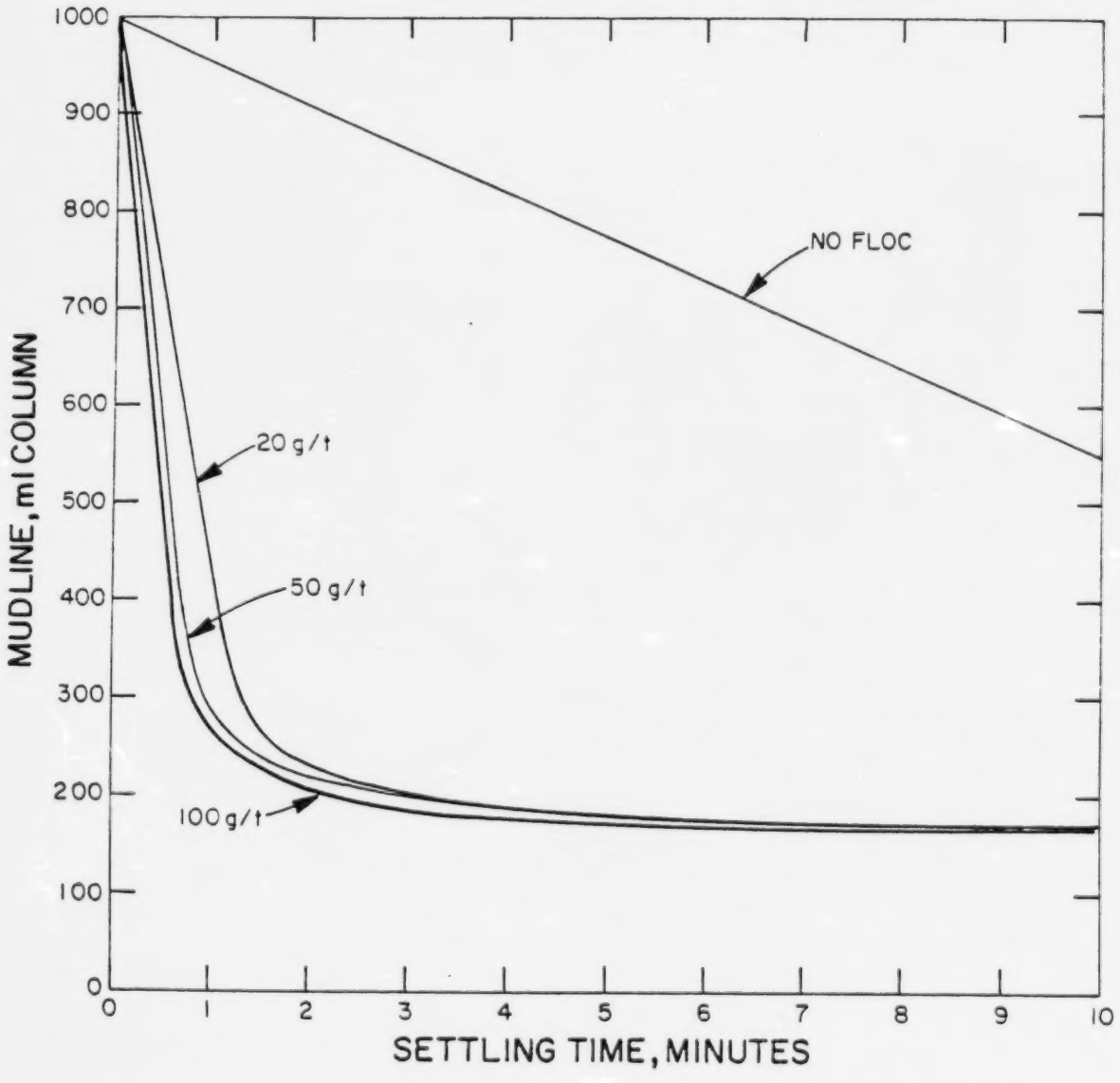

Figure F5 - Settling tests: Preconcentrate (98.5%) and dust (1.5%)
Separan XD vs no flocculant

SETTLING TEST REPORT

Preconcentrate (98.5%) and Pyrite Roasting (1.5%)

Test #54

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	20	156
½	700	30	154
1	440	45	153
1½	265	60	152
2	230	80	151
2½	215	120	150
3	202	150	150
3½	195	180	150
4	188		
5	180		
6	172		
7	169		
8	166		
9	164		
10	161		
11	160		
12	159		
13	159		
14	158		
15.	158		

FLOCCULANT: Superfloc 127 — 20 g/t — Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT — CYL. + SLURRY: 1761.5 g; CYL. EMPTY: 669.0 g; SLURRY: 1092.5 g — Solids: 146.9 g (dry)

SLURRY DENSITY: 13.5 % solids

SETTLING TEST REPORT

Preconcentrate (98.5%) and Pyrite Roasting (1.5%)

Test #55

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	90	160
½	570	120	160
1	290	150	160
1½	240		
2	220		
2½	207		
3	198		
3½	191		
4	186		
5	180		
6	177		
7	175		
8	173		
9	171		
10	170		
15	168		
20	167		
30	164		
45	162		
60	160		

FLOCCULANT: Superfloc 127 50 g/t

Solids S.G.: 2.6

TEMPERATURE: 20°C

WEIGHT CYL. + SLURRY 1761.5 g

CYL. EMPTY 669.0 g

SLURRY 1092.5 g

Solids: 146.9 g (dry)

SLURRY DENSITY: 13.5 % solids

SETTLING TEST REPORT

Preconcentrate (98.5%) and Pyrite Roasting (1.5%)

Test #56

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1010	45	169
¼	750	60	169
½	520	90	168
¾	330	120	167
1	280	150	166
1½	237	180	166
2	215	210	166
2½	202		
3	197		
3½	191		
4	188		
5	182		
6	180		
7	179		
8	178		
9	177		
10	176		
15	172		
20	171		
30	170		

FLOCCULANT: Superfloc 127 100 g/t

Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT CYL. + SLURRY 1761.5 g

CYL. EMPTY 669.0 g

SLURRY 1092.5 g

Solids: 146.9 g (dry)

SLURRY DENSITY: 13.5 % solids

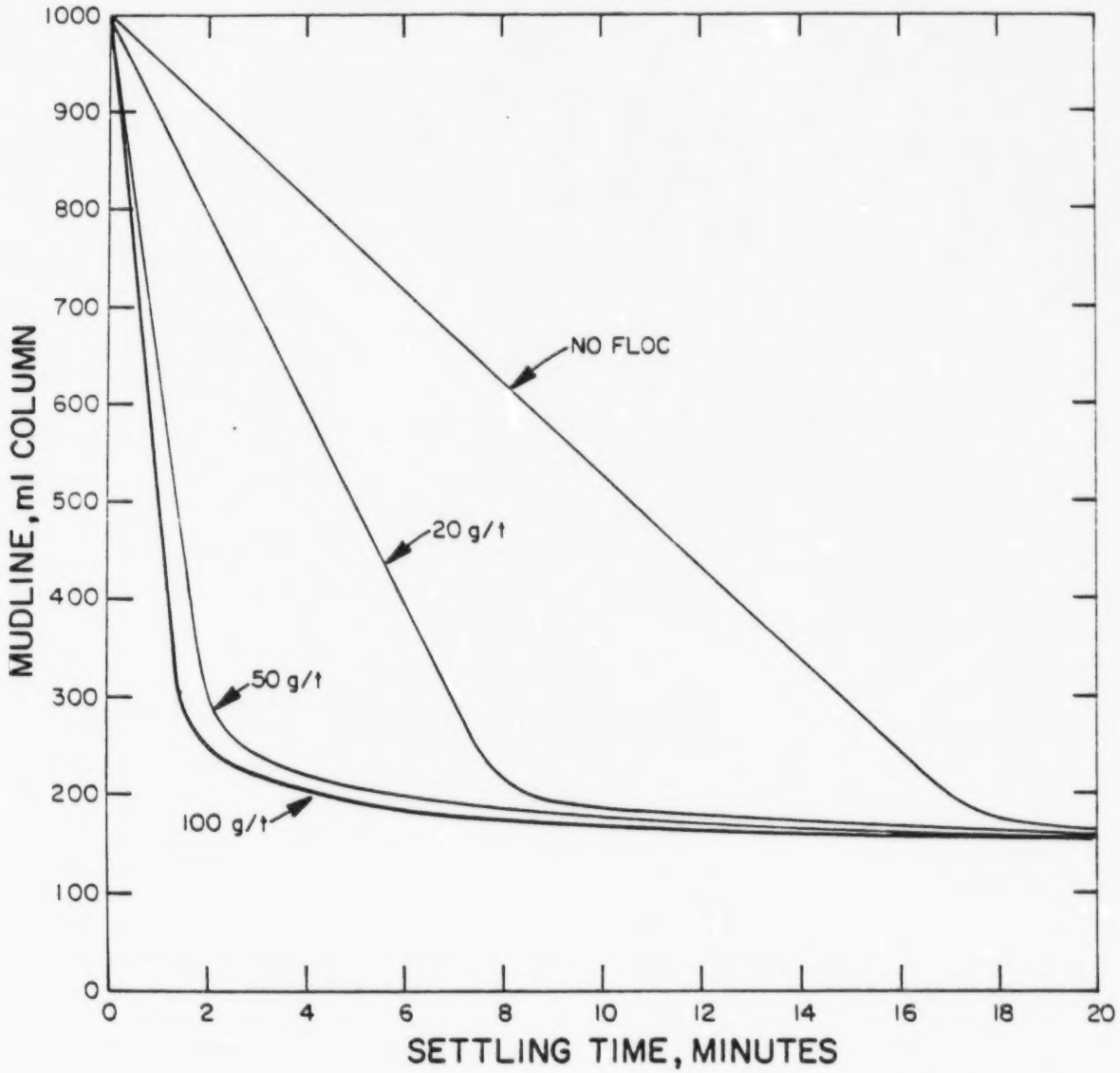

Figure F6 - Settling tests: Preconcentrate (98.5%) and dust (1.5%) Superfloc 127 vs no flocculant

SETTLING TEST REPORT

Preconcentrate (98.5%) and Pyrite Roasting (1.5%)

Test #57

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1000	45	158
½	680	60	157
¾	520	90	157
1	370	120	156
1½	255	150	155
2	230		
2½	212		
3	200		
3½	192		
4	187		
4½	182		
5	180		
6	175		
7	170		
8	169		
9	167		
10	165		
15	161		
20	160		
30	159		

FLOCCULANT: Percol 455 20 g/t

Solids S.G.: 2.6

TEMPERATURE: 22 °C

WEIGHT

CYL. + SLURRY	1727.0 g
CYL. EMPTY	634.6 g
SLURRY	1092.4 g

Solids: 147.6 g (dry)

SLURRY DENSITY: 13.5 % solids

SETTLING TEST REPORT

Preconcentrate (98.5%) and Pyrite Roasting (1.5%)

Test #58

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1005	30	170
¼	720	45	170
½	480	60	170
¾	310	90	169
1	270	120	169
1¼	235	150	168
2	215	180	168
2¼	202	210	167
3	196		
3¼	191		
4	188		
4¼	185		
5	183		
6	180		
7	180		
8	179		
9	178		
10	177		
15	173		
20	172		

FLOCCULANT: Percol 455 — 50 g/t

Solids S.G.: 2.6

TEMPERATURE: 22 °C

WEIGHT — CYL. + SLURRY: 1727.0 g

CYL. EMPTY: 634.6 g

SLURRY: 1092.4 g

Solids: 147.6 g (dry)

SLURRY DENSITY: 13.5 % solids

SETTLING TEST REPORT

Preconcentrate (98.5%) and Pyrite Roasting (1.5%)

Test #59

Time Min	Mudline mL column	Time Min	Mudline mL column
0	1015	90	172
¼	630	120	171
½	360	150	170
¾	290		
1	260		
1½	230		
2	210		
2½	202		
3	198		
4	191		
5	189		
6	187		
7	185		
8	183		
9	181		
10	180		
20	179		
30	177		
45	175		
60	174		

FLOCCULANT: Percol 455 100 g/t

Solids S.G.: 2.6

TEMPERATURE: 22°C

WEIGHT

CYL. + SLURRY	1727.0 g
CYL. EMPTY	634.6 g
SLURRY	1092.4 g

SLURRY DENSITY: 13.5 % solids

Solids: 147.6 g (dry)

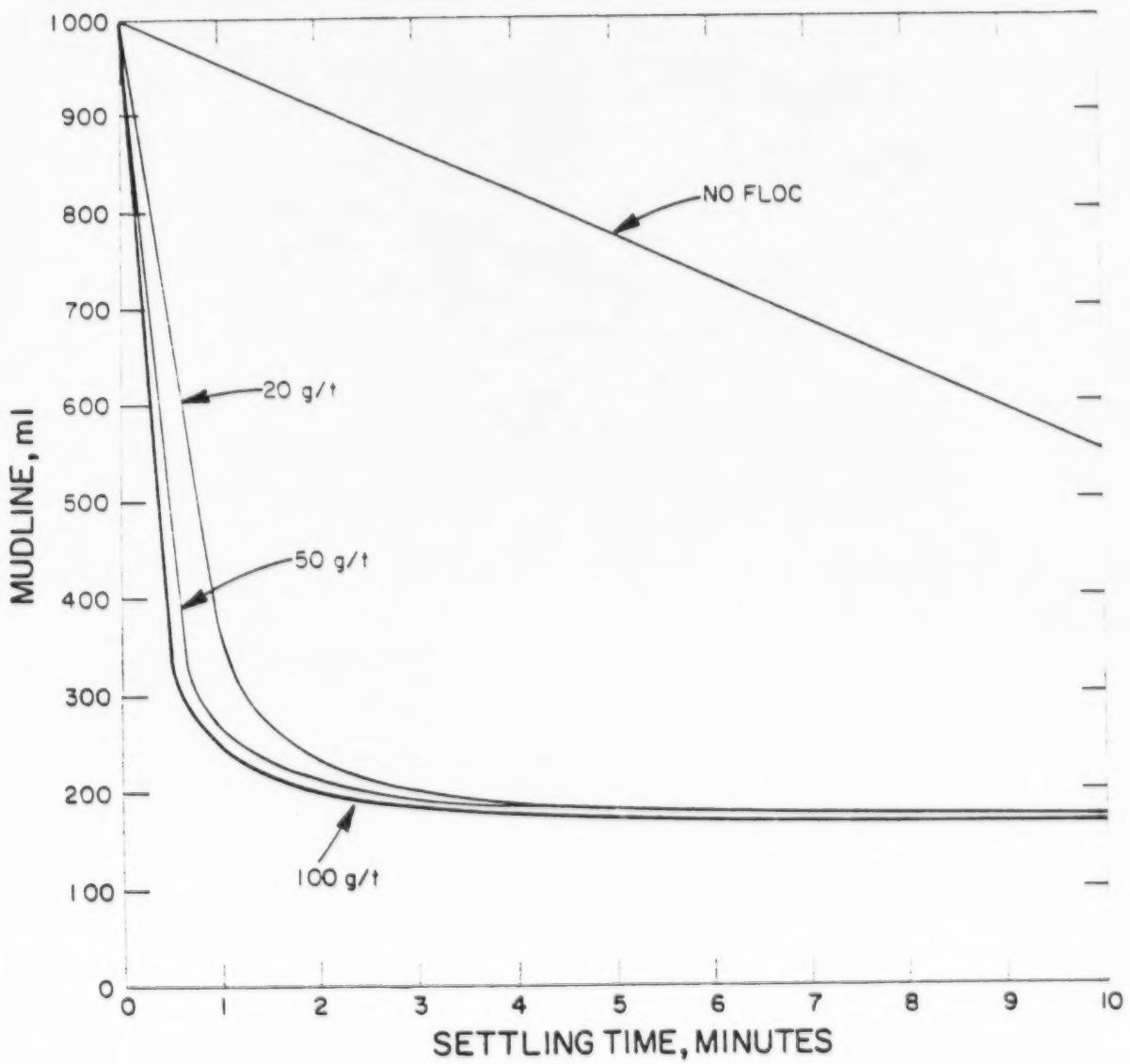

Figure F7 - Settling tests: Preconcentrate (98.5%) and dust 1.5%) Percol 455 vs no flocculant

APPENDIX G

PRECONCENTRATE
FILTER TESTS 17-49

FILTER TEST REPORT

TEST CONDITIONS Preconcentrate with Dust Addition
FILTER CLOTH SPECS. 5524 Neotex from Porritts & Spencer

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.		
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Total Cycle
17	-	-	53.7	6.8	22	30	30	36	36	72
18	-	-	54.5	6.8	22	30	30	37	74	111
19	-	-	54.4	6.8	22	30	30	34	102	136
20	Percol 455	20	54.3	6.8	22	30	30	21	21	42
21	Percol 455	30	54.1	6.8	22	30	30	20	20	40
22	-	-	55.6	6.8	22	30	30	30	30	60
23	-	-	55.7	6.8	22	30	30	35	70	105
24	-	-	55.6	6.8	22	30	30	31	62	93
25	-	-	55.7	6.8	22	30	30	37	111	148

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA		
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry $kg/h/m^2$	Volume mL	Clarity particulates ppm	Rate $L/h/m^2$
			Wet	Dry					
17	None	18	404.0	341.6	15.4	1392.5	232	110	945.7
18	None	18	404.7	346.7	14.3	916.7	232	110	916.7
19	None	18	400.7	346.5	13.5	747.8	236	110	509.3
20	None	18	411.3	346.2	15.8	2419.2	226	110	1579.3
21	None	18	412.3	346.6	15.9	2543.1	228	110	1672.9
22	None	18	405.1	344.2	15.0	1683.7	214	110	1046.8
23	None	18	403.2	347.3	13.9	970.8	220	110	614.9
24	None	18	403.5	346.8	14.1	1094.4	220	110	694.3
25	None	18	400.1	346.5	13.4	687.1	222	110	440.2

FILTER TEST REPORT

TEST CONDITIONS Preconcentrate with Dust Addition
FILTER CLOTH SPECS. 5524 Neotex from Porritts & Spencer

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.		
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Total Cycle
26	Percol 455	20	55.3	6.8	22	30	30	28	28	56
27	Percol 455	30	55.4	6.8	22	30	30	20	20	40
28	Percol 455	20	54.8	6.8	22	30	30	24	24	48
29	Percol 455	50	55.3	6.8	22	30	30	20	20	40
30	Percol 455	100	55.7	6.8	22	30	30	13	13	26
31	Percol 455	20	56.1	6.8	22	30	30	21	21	42
32	Percol 455	20	55.6	6.8	22	30	30	23	46	69

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA		
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry $kg/h/m^2$	Volume mL	Clarity particulates ppm	Rate $L/h/m^2$
			Wet	Dry					
26	None	18	409.7	345.0	15.8	1808.1	214	110	1121.6
27	None	18	412.3	346.1	16.1	2539.5	212	110	1555.5
28	None	18	413.2	345.7	16.3	2113.8	218	110	1333.0
29	None	18	414.6	345.7	16.6	2536.5	210	110	1540.8
30	None	18	417.4	340.7	18.4	3845.9	194	110	2189.9
31	None	18	411.2	348.7	15.2	2436.7	≈210	110	1467.5
32	None	18	396.2	340.4	14.1	1447.9	216	110	918.8

FILTER TEST REPORT

TEST CONDITIONS Preconcentrate with Dust Addition
FILTER CLOTH SPECS. 5524 Neotex from Porritts & Spencer

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.		
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Total Cycle
33	-	-	55.3	6.8	22	30	30	29	29	58
34	-	-	55.3	6.8	22	30	30	32	64	96
35	-	-	55.1	6.8	22	30	30	32	96	128
36	-	-	55.6	6.8	22	30	30	30	90	120
37	Percol 455	20	55.1	6.8	22	30	30	25	75	100
38	Percol 455	30	55.2	6.8	22	30	30	22	22	44
39	Percol 455	30	55.4	6.8	22	30	30	20	40	60
40	Percol 455	30	54.9	6.8	22	30	30	20	60	80

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA		
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry $kg/h/m^2$	Volume mL	Clarity particulates ppm	Rate $L/h/m^2$
			Wet	Dry					
33	None	18	406.0	345.3	15.0	1747.3	218	110	1103.1
34	None	18	402.3	346.1	14.0	1058.1	224	110	684.8
35	None	18	398.7	345.5	13.3	792.2	228	110	522.8
36	None	18	399.8	346.9	13.2	848.4	224	110	547.9
37	None	18	396.6	341.9	13.8	1003.5	224	110	657.4
38	None	18	403.3	338.5	16.1	2257.9	210	110	1400.8
39	None	18	386.6	330.3	14.6	1615.7	210	110	1027.2
40	None	18	391.5	337.7	13.7	1238.9	224	110	821.8

FILTER TEST REPORT

TEST CONDITIONS Preconcentrate with Dust Addition
FILTER CLOTH SPECS. 5524 Neotex from Porritts & Spencer

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.		
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Total Cycle
41	Percol 455	40	54.8	6.8	22	30	30	22	22	44
42	Percol 455	40	54.9	6.8	22	30	30	18	36	54
43	Percol 455	40	55.1	6.8	22	30	30	18	54	72
44	Percol 455	40	54.8	6.8	22	29	23	15	15	30
45	Percol 455	40	54.9	6.8	22	29	23	18	18	36
46	Percol 455	20	55.0	6.8	22	29	23	19	57	76
47	Percol 455	50	54.5	6.8	22	29	23	17	17	34
48	Percol 455	50	54.7	6.8	22	29	23	17	34	51
49	Percol 455	50	54.5	6.8	22	29	27	16	48	64

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA		
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry $kg/h/m^2$	Volume mL	Clarity particulates ppm	Rate $L/h/m^2$
			Wet	Dry					
41	None	18	402.4	337.7	16.1	2252.6	214	110	1427.4
42	None	18	397.6	339.0	14.7	1842.5	220	110	1195.7
43	None	18	396.7	339.7	14.4	1384.7	220	110	896.8
44	None	18	413.4	339.7	17.8	3323.3	206	110	2015.3
45	None	18	405.0	339.6	16.1	2768.6	214	110	1744.7
46	None	18	394.4	340.1	13.8	1313.4	224	110	865.0
47	None	18	405.0	336.5	16.9	2904.7	212	110	1830.0
48	None	18	399.8	337.7	15.5	1943.4	218	10	1254.5
49	None	18	396.3	337.0	15.0	1545.4	222	110	1018.1

APPENDIX H

FLOTATION TAILING LEACH SLURRY
FILTER TESTS 111-125

FILTER TEST REPORT

Flotation Tailing Leach Slurry (Calcine and Dust Added)

TEST CONDITIONS FILTER CLOTH SPECS. POPR-901 F from EIMCO

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.				Ratio WW/Solids
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Wash	Total* Cycle	
111	-	-	48.0	0.5	50	30	30	70	140	205	415	0.5:1
112	-	-	45.1	0.5	50	30	30	65	130	440	635	1:1
113	-	-	49.2	0.5	50	30	30	70	210	235	515	0.5:1
114	-	-	50.7	0.5	50	30	30	62	186	93	341	0.25:1
115	-	-	47.9	0.5	50	30	30	75	150	125	350	0.25:1
116	-	-	50.5	0.5	50	30	30	70	140	395	605	0.75:1
117	-	-	53.5	0.5	50	30	30	57	171	353	581	0.75:1
118	-	-	55.8	0.5	50	30	30	65	65	270	400	0.5:1

*No allowance for cake discharge and safety factor

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA			Wash Water $L/h/m^2$
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry $kg/h/m^2$	Volume mL	Clarity	Rate $L/h/m^2$	
			Wet	Dry						
111	None	14	300.05	259.95	13.4	185	356	Cloudy	251	106
112	None	15	298.23	244.30	18.1	113	505	Clear	233	138
113	None	14	305.70	257.51	15.8	146	332	Clear	189	85
114	None	15	311.00	272.91	12.3	234	272	Clear	233	64
115	None	14	294.19	255.11	13.3	213	288	Clear	241	63
116	None	14	326.85	269.70	17.5	130	400	Clear	194	109
117	None	15	336.36	293.53	12.7	148	390	Clear	196	113
118	None	15	366.67	303.75	17.1	222	290	Clear	212	110

FILTER TEST REPORT

Flotation Tailing Leach Slurry (Calcine and Dust Added)

TEST CONDITIONS FILTER CLOTH SPECS. POPR-901 F from EIMCO

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.				Ratio WW/Solids
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Wash	Total* Cycle	
119	SF-127	27	50.9	0.5	50	30	30	25	25	57	107	0.5:1
124	SF-127	22	51.9	0.5	50	30	30	31	62	77	170	0.5:1
125	SF-127	20	54.5	0.5	50	30	30	25	50	92	167	0.75:1
120	SF-127	11	52.4	0.5	50	30	30	40	40	117	197	0.5:1
123	SF-127	11	54.5	0.5	50	30	30	41	82	59	182	0.25:1
121	SF-127	11	52.6	0.5	50	30	30	42	84	163	289	0.5:1
122	SF-127	10	55.6	0.5	50	30	30	50	100	360	510	0.75:1

*No allowance for cake discharge and safety factor

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA			Wash Water, L/h/m²
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry kg/h/m²	Volume mL	Clarity	Rate L/h/m²	
			Wet	Dry						
119	None	16	330.29	275.00	16.7	752	362	Clear	990	410
124	None	16	322.19	274.73	14.7	473	334	Clear	575	258
125	None	15	352.32	297.55	15.6	521	390	Clear	684	394
120	None	16	358.13	276.76	22.7	411	300	Clear	446	223
123	None	16	339.18	283.48	16.4	456	235	Clear	378	121
121	None	15	342.06	275.96	19.3	280	296	Clear	300	152
122	None	16	371.13	297.81	19.8	171	364	Clear	209	129

FILTER TEST REPORT - WASHING EFFICIENCY

SAMPLE: Flotation tailing leach slurry (Calcine and dust added)

FILTER CLOTH SPECS: POPE 901 F from EIMCO

Test No.	LIQUID PHASE IN LEACH SLURRY								FILTRATE								RESIDUE				WASH EFFICIENCY %		
	Leach Slurry wt, g	Vol L	U		Th		Ra^{226}		Vol L	U		Th		Ra^{226}			wt, g	U %	Th %	Ra^{226} pCi/g	U	Th	Ra^{226}
			g/L	g	g/L	g	pCi/L	pCi		g/L	g	g/L	g	pCi/L	pCi								
112	541.41	0.297	0.81	0.2465	0.28	0.0832	91,700	27,235	0.505	0.43	0.2172	0.14	0.0707	64,700	32,673		244.30	0.016	0.013	164	88.1	85.0	-
116	534.63	0.265	0.83	0.2200	0.28	0.0742	91,700	24,300	0.400	0.51	0.2040	0.16	0.0660	57,800	23,120		269.70	0.016	0.013	191	92.7	86.3	95.1
117	548.55	0.255	0.83	0.2117	0.28	0.0714	91,700	23,384	0.190	0.58	0.2262	0.18	0.0702	57,700	22,503		293.53	0.012	0.013	214	-	98.3	96.2
118	544.21	0.240	0.83	0.1992	0.28	0.0672	91,700	22,008	0.290	0.72	0.2088	0.24	0.0696	55,300	16,037		301.75	0.011	0.015	199	-	-	72.9
111	541.41	0.282	0.83	0.2341	0.28	0.0790	91,700	25,859	0.156	0.60	0.2136	0.18	0.0641	70,300	25,026		259.95	0.011	0.014	185	91.2	81.2	96.8
113	523.18	0.266	0.83	0.2208	0.28	0.0745	91,700	24,392	0.332	0.64	0.2125	0.19	0.0611	62,600	20,783		257.51	0.012	0.011	191	96.2	84.7	85.2
115	532.71	0.278	0.83	0.2307	0.28	0.0778	91,700	25,493	0.288	0.68	0.1958	0.24	0.0691	61,800	17,654		255.11	0.017	0.011	208	84.9	88.8	69.3
114	538.45	0.266	0.83	0.2208	0.28	0.0745	91,700	24,392	0.272	0.71	0.1931	0.24	0.0653	58,600	15,939		272.91	0.014	0.015	191	87.5	87.7	65.4
122	535.31	0.238	0.94	0.2237	0.32	0.0762	73,500	17,493	0.364	0.61	0.2220	0.20	0.0728	43,900	15,980		297.81	0.011	0.014	212	99.2	95.6	91.4
120	528.59	0.252	0.94	0.2369	0.32	0.0806	73,500	18,522	0.300	0.73	0.2190	0.24	0.0720	57,400	17,220		276.76	0.015	0.016	240	92.5	89.3	94.0
121	524.67	0.249	0.94	0.2341	0.32	0.0797	73,500	18,302	0.296	0.66	0.1954	0.24	0.0710	46,700	13,823		275.96	0.016	0.016	219	83.5	89.1	75.5
123	520.02	0.237	0.94	0.2228	0.32	0.0758	73,500	17,420	0.235	0.85	0.1998	0.28	0.0658	38,000	8,930		283.48	0.016	0.015	217	89.7	86.8	51.3
125	545.88	0.248	0.94	0.2331	0.32	0.0794	73,500	18,228	0.190	0.56	0.2184	0.18	0.0702	76,000	14,060		297.55	0.013	0.016	219	93.7	88.5	77.0
124	529.30	0.255	0.94	0.2397	0.32	0.0816	73,500	18,743	0.114	0.58	0.1937	0.21	0.0768	99,000	11,026		274.73	0.014	0.016	235	80.8	94.1	69.5
119	540.05	0.265	0.94	0.2491	0.32	0.0848	73,500	19,478	0.162	0.61	0.2281	0.14	0.0507	48,000	17,376		275.00	0.011	0.013	218	91.6	59.8	89.2

APPENDIX I

PRECONCENTRATE LEACH SLURRY
FILTER TESTS 126-145

FILTER TEST REPORT

Preconcentrate Leach Slurry (Calcine and Dust Added)

TEST CONDITIONS FILTER CLOTH SPECS. POPR-901 F from EIMCO

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.				Ratio WW/Solids
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Wash	Total* Cycle	
126	-	-	48.7	0.5	50	30	30	120	240	465	825	0.5:1
127	-	-	49.9	0.5	50	30	30	120	120	257	497	0.25:1
128	-	-	48.9	0.5	50	30	30	130	260	830	1220	0.25:1
129	Superfloc 127	29	50.4	0.5	50	30	30	20	40	50	110	0.5:1
130	Superfloc 127	11	49.1	0.5	50	30	30	35	70	60	165	0.5:1
131	Superfloc 127	11	49.8	0.5	50	30	30	55	110	165	330	0.75:1
132	Superfloc 127	11	50.8	0.5	50	30	30	45	90	175	310	0.5:1
133	Superfloc 127	11	50.3	0.5	50	30	30	60	120	60	240	0.25:1
134	Superfloc 127	19	51.0	0.5	50	30	30	42	84	83	209	0.5:1

*No allowance for cake discharge and safety factor

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA			Wash Water $L/h/m^2$
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry $kg/h/m^2$	Volume mL	Clarity	Rate $L/h/m^2$	
			Wet	Dry						
126	None	15	329.15	270.14	17.9	96	326	Clear	116	53
127	None	16	358.73	279.68	22.0	165	240	Clear	141	44
128	None	15	325.83	258.18	20.8	62	230	Clear	55	18
129	None	15	338.10	279.75	17.3	746	344	Clear	915	399
130	None	15	329.35	273.41	17.0	485	348	Clear	617	266
131	None	16	336.39	274.62	18.4	244	405	Clear	359	200
132	None	15	330.25	272.99	17.3	258	328	Clear	310	142
133	None	15	326.26	272.19	16.6	332	258	Clear	315	92
134	None	16	320.14	269.17	15.9	377	330	Clear	462	210

FILTER TEST REPORT

Preconcentrate Leach Slurry (Calcine and Dust Added)

TEST CONDITIONS FILTER CLOTH SPECS. POPR-901 F from EIMCO

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.				Ratio WW/Solids
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Wash	Total* Cycle	
135	Superfloc 127	22	50.2	0.5	50	30	30	35	70	60	165	0.5:1
136	Superfloc 127	23	50.8	0.5	50	30	30	31	62	97	190	0.75:1
137	Superfloc 127	22	49.4	0.5	50	30	30	32	64	28	124	0.25:1
138	Superfloc 127	22	49.9	0.5	50	30	30	32	32	63	127	0.5:1
139	Superfloc 127	22	50.2	0.5	50	30	30	34	34	100	168	0.75:1
140	Superfloc 127	22	50.6	0.5	50	30	30	33	33	34	100	0.25:1
141	Superfloc 127	11	50.0	0.5	50	30	30	75	75	155	305	0.5:1
142	Superfloc 127	12	48.9	0.5	50	30	30	62	62	183	307	0.75:1
143	Superfloc 127	11	49.6	0.5	50	30	30	60	60	100	220	0.5:1

*No allowance for cake discharge and safety factor

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA			Wash Water L/h/m²
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry kg/h/m²	Volume mL	Clarity	Rate L/h/m²	
			Wet	Dry						
135	None	16	325.60	274.18	15.8	486	340	Clear	603	266
136	None	15	315.72	265.58	15.9	409	400	Clear	615	347
137	None	15	326.79	276.36	15.4	652	278	Clear	656	177
138	None	15	329.45	272.45	17.3	628	340	Clear	784	346
139	None	15	333.31	274.56	17.6	478	408	Clear	711	392
140	None	15	331.17	273.01	17.6	799	258	Clear	755	220
141	None	15	349.68	279.14	20.2	268	318	Clear	305	144
142	None	15	322.27	258.55	19.8	247	382	Clear	364	215
143	None	16	335.25	273.57	18.4	364	334	Clear	444	200

FILTER TEST REPORT

TEST CONDITIONS Preconcentrate Leach Slurry (Calcine and Dust Added)
FILTER CLOTH SPECS. POPR-901 F from EIMCO

Test No	FLOCCULANT		SLURRY			FILTER VAC. (inch Hg)		FILTER TIME. SEC.				Ratio WW/Solids
	Type	g/t	% Solids	pH	Temp °C	Form	Dry	Form	Dry	Wash	Total* Cycle	
144	Superfloc 127	11	50.4	0.5	50	30	30	55	55	50	160	0.25:1
145	Superfloc 127	18	52.1	0.5	50	30	30	34	34	71	139	0.5:1

*No allowance for cake discharge and safety factor

TEST RESULTS

Test No	FILTER CAKE DATA						FILTRATE DATA			Wash Water L/h/m²
	No. of Cracks	Thick mm	Weight, g		% Moisture	Rate, Dry kg/h/m²	Volume mL	Clarity	Rate L/h/m²	
			Wet	Dry						
144	None	16	339.19	276.04	18.6	505	256	Clear	468	137
145	None	16	335.71	276.59	17.6	582	320	Clear	674	316

FILTER TEST REPORT — WASHING EFFICIENCY

SAMPLE: Precommittate leach slurry
(Calcine and dust added)

FILTER CLOTH SPECS: POPS 901 F Dacron FINISH

Test No.	Leach Slurry wt., g	LIQUID PHASE IN LEACH SLURRY					FILTRATE					RESIDUE			WASH EFFICIENCY %	
		Vol L	D		Pb		Vol L	D		Pb		wt., g	D %	Pb %	D	Pb
			g/L	g	g/L	g		g/L	g	g/L	g					
126	554.49	0.284	2.33	0.6617	0.75	0.2130	0.326	1.97	0.6422	0.60	0.1956	270.14	0.069	0.058	97.1	91.8
127	560.83	0.281	2.33	0.6547	0.75	0.2108	0.240	2.79	0.6696	0.78	0.1872	279.68	0.071	0.060	–	88.8
128	528.05	0.270	2.33	0.6291	0.75	0.2025	0.230	2.49	0.5727	0.79	0.1817	258.18	0.077	0.057	91.0	89.7
142	529.20	0.271	2.33	0.6314	0.75	0.2033	0.382	1.44	0.5501	0.52	0.1986	258.55	0.060	0.071	87.1	97.7
131	551.74	0.277	2.33	0.6454	0.75	0.2078	0.405	1.60	0.6480	0.48	0.1944	274.62	0.065	0.057	–	91.6
141	558.18	0.279	2.33	0.6501	0.75	0.2093	0.318	1.96	0.6233	0.64	0.2035	279.14	0.066	0.057	95.9	97.1
143	551.98	0.278	2.33	0.6477	0.75	0.2085	0.334	1.82	0.6079	0.62	0.2071	273.57	0.064	0.067	93.8	99.1
130	556.90	0.283	2.33	0.6617	0.75	0.2123	0.368	1.98	0.6890	0.58	0.2018	274.41	0.067	0.056	–	95.1
132	537.37	0.264	2.33	0.6151	0.75	0.1980	0.328	1.85	0.6068	0.57	0.1870	272.99	0.091	0.059	98.7	94.4
144	547.56	0.272	2.33	0.6338	0.75	0.2040	0.256	2.22	0.5683	0.76	0.1946	276.04	0.071	0.071	89.7	95.4
133	541.33	0.269	2.33	0.6268	0.75	0.2018	0.258	2.30	0.5934	0.71	0.1832	272.19	0.067	0.057	94.7	90.8
145	531.19	0.255	2.33	0.5942	0.75	0.1913	0.320	1.81	0.5792	0.60	0.1920	276.59	0.071	0.060	97.5	
134	527.79	0.259	2.33	0.6035	0.75	0.1943	0.330	1.76	0.5808	0.60	0.1980	269.17	0.067	0.056	96.2	
139	547.38	0.271	2.33	0.6301	0.75	0.2068	0.408	1.52	0.6202	0.50	0.2040	274.56	0.081	0.061	97.5	99.6
136	522.55	0.257	2.33	0.5988	0.75	0.1928	0.400	1.54	0.6160	0.49	0.1960	265.58	0.080	0.057	–	
138	545.99	0.274	2.33	0.6384	0.75	0.2055	0.340	1.72	0.5848	0.58	0.1972	272.45	0.081	0.060	91.6	96.0
135	545.98	0.272	2.33	0.6338	0.75	0.2040	0.340	1.75	0.5950	0.56	0.1904	274.18	0.078	0.057	93.9	93.3
140	539.62	0.267	2.33	0.6221	0.75	0.2003	0.258	2.10	0.5418	0.71	0.1883	273.01	0.066	0.060	87.1	94.0
137	559.64	0.281	2.33	0.6594	0.75	0.2123	0.278	2.30	0.6394	0.70	0.1946	276.36	0.085	0.060	97.0	91.7
129	555.39	0.276	2.33	0.6431	0.75	0.2070	0.344	1.80	0.6192	0.57	0.1961	279.75	0.068	0.056	96.3	94.7